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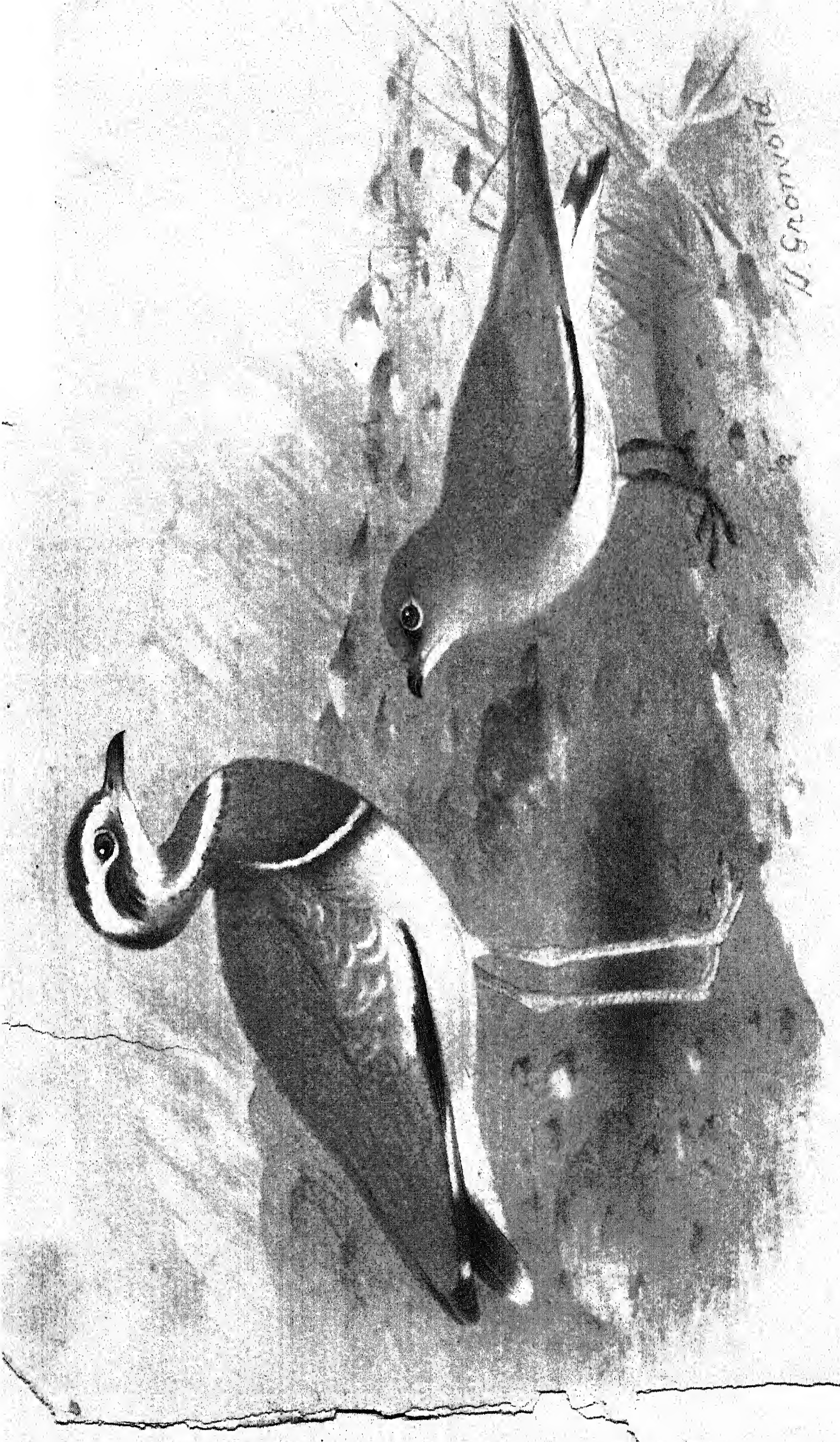

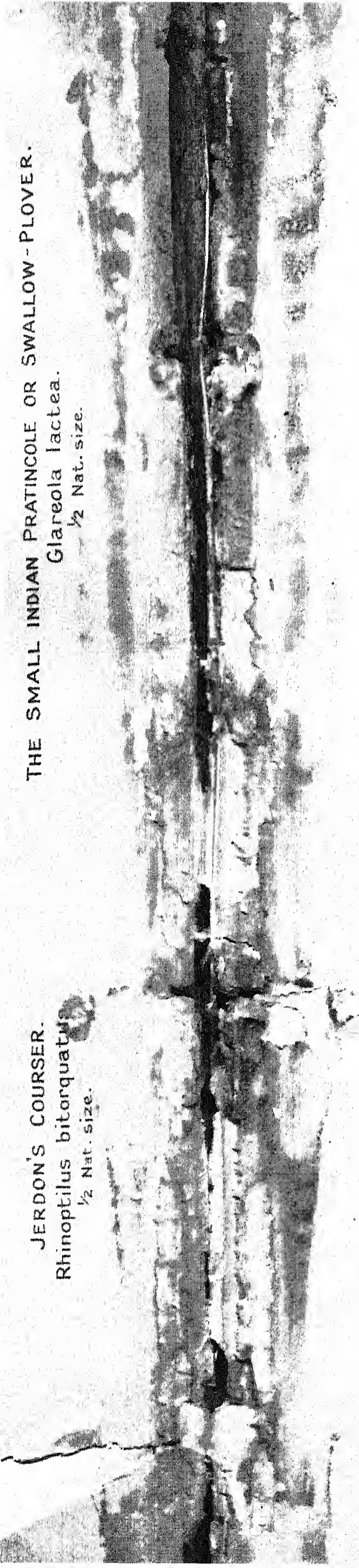

THE SMALL INDIAN PRATINCOLE OR SWALLOW-PLOVER.
Glareola lactea.
½ Nat. size.

JERDON'S COURSER.
Rhinoptilus bitorquatus.
½ Nat. size.

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THE GAME BIRDS OF THE INDIAN EMPIRE

BY

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VOL. V

THE WADERS AND OTHER SEMI-SPORTING BIRDS

PART XI

(*With a coloured plate*)

(*Continued from page 752 of Vol. XXXIII*)

Family: GLAREOLINÆ

Key to SUB-FAMILIES

A. No hind toe; tarsus equal to one-third of wing or more ... ... *Cursoriinæ.*
B. A small hind toe; tarsus equal to about one-fifth of wing ... ... *Glareolinæ.*

Sub-family: CURSORIINÆ

Key to GENERA

A. Bill rather long, narrow and slightly curved; no pectoral bands ... ... *Cursorius.*
B. Bill straight; breast with two transverse bands ... ... *Rhinoptilus.*

Genus: CURSORIUS

Cursorius Lath., Ind. Orn., i, p. 751 (1790).
Type by tautonomy, *Charadhius cursor* Latham.

Key to Species

A. Crown rufous in front, grey behind ... *C. cursor.*
B. Crown chestnut throughout ... ... *C. coramandelicus.*

Cursorius cursor cursor

The Cream-coloured Courser

Charadrius cursor Latham, Gen. Synop. Birds, Suppl. i, p. 293, (1787) (England).

Cursorius gallicus.—Blanf. and Oates, iv, p. 211.

Vernacular Names.—None recorded.

Description.—Forehead and fore-crown rufous, the lores paler; hind-crown and nape ashy-grey; a nuchal patch black; supercilia white, meeting behind the black patch; a second line of black from the eye below the supercilium; upper plumage, wing-coverts and inner secondaries rufous-sandy; primaries and primary coverts black; outer secondaries rufous-sandy, tipped white and with a subterminal patch; tail-feathers sandy-rufous, the central with an obsolete black spot, the lateral with broad black subterminal spots and white tips, the white extending to the outer web of the outermost feathers; wing-lining and axillaries black; lower plumage paler sandy-rufous, the chin and throat paler and the under tail-coverts almost or quite white.

Colours of soft parts.—Iris brown; bill black; legs yellowish or fleshy-white.

Measurements.—Wing 150 to 171 mm.; tail 58 to 72 mm.; tarsus 55 to 60 mm.; culmen 21 to 26 mm.; generally 23 to 25 mm. Sexes alike.

Young birds are a paler duller sandy and are barred on the upper plumage with blackish-brown; there is no grey or brown on the crown.

Distribution.—North Africa, Morocco to Egypt; South-West Asia from Palestine to North-West India, South Persia, Afghanistan and Baluchistan. In India it occurs as far South-East as Ajmere, Jodhpur, Erinpura and South to Cutch. In Europe it occurs regularly as far as Italy and South France and sporadically to England.

Nidification.—The Cream-coloured Courser does not breed within Indian limits but its eggs have been taken in Mesopotamia and it breeds thence West throughout Northern Africa. Sladen obtained their eggs in Palestine up to the end of June but in the Sinai Desert Pitman found them breeding from the end of March to early May and succeeded in obtaining a fine series of their eggs. The birds make no nest but lay their two eggs on the bare ground, sometimes scratching a shallow receptacle for them and at other times not even doing this. The ground selected is open desert, either sand or barren stony country and, though occasionally the eggs may be deposited under the protection of a tuft of grass or some small scrubby bush, they are, as a rule, laid absolutely in the open. Naturally under these circumstances the birds are very close sitters, as otherwise the eggs would soon become cooked by the sun. Sladen remarks that their nests are very difficult to find, as the

eggs assimilate so closely to the ground on which they are placed. The birds sneak away whilst the intruder is still at some distance but, if he remains still, within a very few moments she will be seen returning, approaching the eggs by short and rapid runs and immediately sitting down upon them. It is then easy to walk up to the eggs and pick them up. Although they do not breed actually in colonies, several nests may be found within a short distance of one another. The full clutch is two, though in one instance Dresser had a set of three sent him. The eggs have a ground colour of pale sandy grey or buff and are freckled all over with darker sandy brown or brown, the freckles occasionally becoming rather larger spots or tiny streaks. In most specimens there are secondary marks of pale grey equally numerous and similarly scattered over the entire surface. In a few eggs the markings are more numerous at the larger end, where they form an indefinite ring or cap. Twenty eggs average 34·7 by 27·2 mm.; maxima **39·3** by **29·0** mm.; minima **32·2** by 26·5 mm. and 34·0 by **25·5 mm.**

Habits.—This Courser frequents nothing but the most bare desert country; either wide sandy wastes such as are found in Africa and Palestine, the more stony and barren, though equally desert, country further East or, the wide expanses of caked yellow mud of the Mesopotamian open lands. So closely does this bird blend with its surroundings that so long as it is quiescent it is extraordinarily difficult to detect but, as it is a very restless bird when feeding, its actions soon catch the eye. It runs with great speed and when disturbed will often continue to run in front of the disturber for some distance before it takes to flight. On the wing it is exceptionally strong and graceful, constantly wheeling and twisting in the air much in the manner of some of the Sand-Grouse. When suddenly frightened it often seeks to avoid detection by squatting close to the ground with head outstretched and eyes almost closed and, if it has not been spotted before squatting, it is possible to pass within a very few feet of it without detection. Its food consists almost entirely of insects, whilst it manages to keep fat and in splendid condition in country where one would have thought it was more likely to starve. It is quite good to eat and, so far as its flight goes, it is worthy of a shot but at the same time hardly ranks as a game bird.

Cursorius coromandelicus

The Indian Courser

Charadrius coromandelicus Gmelin, Syst. Nat., i, p. 692 (1788) (Coromandel Coast.)

Cursorius coromandelicus.—Blanf. and Oates, iv, p. 210.

Vernacular Names.—*Nukri* (Hind.); *Yerro Chitawa, Durawayi* (Tel.).

Description.—Crown rich rufous with a small black nuchal spot; a broad white supercilium meeting behind this black spot; lores black and a black band through the eye, down the neck and surrounding the white; hind-neck rufous; upper tail-coverts white; remainder of upper plumage light brown, slightly sandy; primaries black; outer

secondaries black with white tips and brown towards their ends; inner secondaries, lesser and median coverts like the back; greater coverts black; lateral tail-feathers with broad white tips and black sub-tips; breast and flanks chestnut, deepening on the abdomen and succeeded by a black patch; lower abdomen and posterior flanks grey, changing to white on the vent and lower tail-coverts; chin and throat white; fore-neck pale rufous; under wing-coverts black.

Colours of soft parts.—Iris dark brown or hazel; bill black; legs and feet ivory-white or creamy-white.

Measurements.—Wing, ♂ 136 to 147 mm., ♀ 141 to 156 mm.; tail 50 to 57 mm.; tarsus 50 to 58 mm.; culmen 19 to 21 mm.

Young birds are dull buff above, irregularly barred with blackish brown; there is a small pale supercilium but no black on the crown; the breast is dull rufous, more or less barred with blackish; chin and abdomen white.

Distribution.—The drier, more open and desert portions of India from North Ceylon to North-West India and Western Bengal. It is common in the deforested parts of Travancore but is rare on the Malabar coast and, again, is absent from the pure desert country of Cutch, Sind and the North-West Province.

Nidification.—The differences between the nidification of the Cream-coloured Courser and our Indian bird are very remarkable instances of the adaptation of birds to their natural surroundings and form an admirable example of evolution by environment. The present species, like the last, lays its eggs on the ground but, as a site for its nesting hollow, it selects either ploughed fields, dark coloured fallow land or dark brown sandy wastes, or even—as in Malabar—the sea coasts. In this latter instance, however, instead of depositing its eggs on the bare yellow sand, it selects either the debris just above high water mark or patches of dark coloured drift still higher up. In no case that has been recorded have its eggs ever been taken on sand or on pale coloured desert land. As we might expect, the eggs differ greatly from those of the preceding bird and closely match the black soil and yellow debris upon which they are laid. The ground colour varies from a pale stone colour to a rich yellow buff, whilst the markings consist of patches and smears or endless lines and scriggles of black which cover the greater part of the surface. In a few eggs the marks are more brown than black and in a few others, a considerable portion of the rich buff ground colour shows up distinctly. In shape the eggs are like all others of this family—very broad elipses, in some cases almost cylindrical. Forty eggs average 30·7 by 24·0 mm.; maxima 34·1 by 23·9 mm. and 31·5 by 26·1 mm.; minima 28·2 mm. by 23·1 mm. and 30·2 by 22·1 mm. The eggs are always two only and the principal breeding months are April and May, though eggs may be found as late as June and sometimes in Western India as late as July.

Habits.—The Indian Courser keeps entirely to open country but, unlike the Cream-coloured Courser, prefers cultivated country or waste ground which is covered by very thin scrub or a certain amount of grass, though it never resorts to the forest or to thick cover. Although it is found over such a large area, it is rather

particular as to its habitat and whilst, on the one hand, it is not found in areas with the heaviest rainfall, it equally avoids completely desert country. When incubating its eggs this Courser sits very close, only creeping away at the very last moment on being disturbed and returning quickly to its eggs at the first opportunity. At other times it is shy and very difficult to approach, generally seeking safety by running away with great speed. In the non-breeding season it occasionally collects in small flocks and these are just as difficult to approach as single birds. At the first sign of danger they may be seen standing very erect with their heads stretched in the direction from which danger approaches. Then with one accord, down go heads and tails and every bird races off for a hundred yards or so, when the erect attitude is once more adopted and the approaching danger surveyed anew. They fly very strongly and swiftly, although they seem to have more confidence in their legs than in their wings. Their food is almost entirely insectivorous and their flesh not bad to eat though generally very dry.

Genus : RHINOPTILUS

Rhinoptilus Strickland, P.Z.S., 1850, p. 220, Jan. 1852.
Type.—Cursorius licinctus Temminck.

RHINOPTILUS BITORQUATUS

Jerdon's Courser

Rhinoptilus bitorquatus Blyth, J.A.S.B., xvii, pt. 1, p. 254 (1848), ex Jerdon MS. (Eastern Ghats); Blanford and Oates, iv, p. 212.

Vernacular Names.—Adava-wuta-titti (Tel.).

Description.—Forehead, supercilia and a broken central coronal streak pale buff or white; remainder of crown and hind-neck dark brown, surrounded by the pale buff; tail-coverts white; remainder of upper plumage, scapulars and inner secondaries brown; tail-feathers blackish, the outermost broadly white at the base and all the lateral feathers with white apical spots on the outer webs; median coverts paler grey-brown with broad white edges forming a conspicuous wing-bar; greater and primary coverts black; primaries black, the outermost with a broad white patch on the outer web, joining obliquely with a similar broad white subterminal patch on the inner web, the white decreasing to a small spot on the inner web of the fourth; outer secondaries black, broadly edged with white on the inner webs; chin and throat white; fore-neck rufous surrounded by a black-edged white band; breast brown with a broad white belt across the lower part; under wing-coverts black and white; axillaries, lower breast, flanks and abdomen creamy-white changing to white on the under tail-coverts.

The feathers of the upper parts are obsoletely edged paler and the wing-coverts more definitely so, a character possibly of the juvenile plumage.

Colours of soft parts.—Iris dark brown; bill blackish-horny at the tips of both mandibles, pale yellow from the nostrils to the gape, legs pale yellowish-white with a fleshy tinge, soles flesh-coloured, nails horny.

Measurements.—Wing 161 to 168 mm.; tail 64 to 65 mm.; tarsus 68 mm.; culmen 18 to 19 mm.

Distribution.— The forest country from the Godavery Valley to the neighbourhood of Madras. Jerdon discovered it in Nellore and Cuddapah and Blanford obtained it close to Sironcha on the Godavery and again near Bhadrachalam, whilst, in 1900, Howard Campbell saw it near Anantapur, much farther West.

Nidification.—Very little is known about the breeding of this rare bird but a writer in the 'Asian', about 1895, describes finding its eggs laid on the ground in thin scrub jungle. The eggs were said to be almost exactly like those of the Indian Courser, the ground colour a bright yellow, almost obliterated by black scrawls, patches and spots. They were laid on the ground, two in number, with no depression and without concealment.

Habits.—Jerdon's Courser, unlike all the other birds of this family, seems to frequent thin scrub or deciduous bush jungle, rather than completely open country. Jerdon and Blanford both record finding it, not only in scrub, but also in thin forest. Campbell saw it in dry bush jungle and Howard obtained a male in quite thick scrub. It seems to keep always in pairs, both in and out of the breeding season and, whilst it generally seeks safety by running away on foot into denser cover, it is said to fly as well as, or even more strongly than, the more common Coursers. Jerdon says that it is has a plaintive cry.

Sub-family: GLAREOLINÆ

Genus: Glareola

Glareola, Brisson, Orn., i, p. 48 (1760).
Type by tautonomy *Hirundo pratincola.*

Key to Species

A. Tail deeply forked; wing exceeding 170 mm.
 (*a*) Outer tail-feathers exceeding central tail-feathers by about 50 mm. ... *G. pratincola.*
 (*b*) Outer tail-feathers exceeding central tail-feathers by 25 mm. or less ... *G. maldivarum.*
B. Tail nearly even; wing under 170 mm. ... *G. lactea.*

Glareola pratincola pratincola

The Collared Pratincole.

Hirundo pratincola Linn., Syst. Nat., 12th ed., p. 315 (1766) (Austria).

Glareola pratincola.—Blanf. and Oates, iv, p. 216.

Vernacular Names.—None recorded.

Description.—Upper plumage brown, faintly tinged with olive the back and sides of the neck more pale rufous; lores and a line under the eye running down the sides of the neck and in a narrow gorget across the upper breast black, indistinctly edged with white; rump and shorter tail-coverts white; longer tail-coverts brown with paler edges; tail feathers black with broad white bases; chin and throat inside the gorget pale rufous; breast pale isabelline-rufous changing to rufous on the lower breast and to pure white on the abdomen and under tail-coverts; lesser and median under wing-coverts and axillaries deep rufous.

Colours of soft parts.—Iris dark brown; bill black, the gape reddish; legs and feet dusky black.

Measurements.—Wing 176 to 200 mm.; tail, longest outermost feather 102 to 119 mm.; shortest central feathers 54 to 58 mm.; tarsus 30 to 32 mm.; culmen 15 to 16 mm.

Young birds are olive-brown above, the feathers pale tipped and with black sub-edges, there is no black neck-line or gorget and the breast is mottled brown and rufous-white.

Distribution.—South Europe, Central and Western Asia to Sind and Cutch. In Winter it wanders into Africa. In India it breeds in Sind and on the Mekran coast and struggles as far as Allahabad, the Deccan and Ratnagiri.

Nidification.—Within Indian limits the Collared Pratincole breeds from April to May in Sind, Cutch and all up the Mekran coast, very often in company with the Large Indian Pratincole. It breeds in April and May over the greater part of Europe, whilst in Palestine and Mesopotamia it lays principally in June. The eggs, which number two or three, are laid on the ground, a depression being sometimes made by the birds for their reception but without any lining or nest of any kind. The ground selected is almost invariably dark-coloured waste ground, edges of swamps or wide stretches of sun-burnt mud, and, in the majority of cases, without grass, scrub or any other cover. Occasionally the bird selects a patch of ploughed land or even of land in which there is stubble or a crop of very short growth; such instances are, however, quite exceptional. The eggs are very like those of the Indian Courser but are less richly coloured, the ground colour being more tinged with grey and less with rich yellow or buff. The markings consist of numerous spots and blotches of blackish brown scattered over the whole surface but generally rather less thickly than they are in the eggs of the Coursers. Scrolled eggs are quite unusual. Forty Indian eggs average 30·5 by 23·4 mm.; maxima **31·6** by 23·1 mm. and 30·7 by **24·2** mm.; minima **29·2** by 24·0 mm. and 30·0 by **22·4** mm. Where one nest is found, two or three others may generally be found quite close by, whilst occasionally, the birds breed in colonies of considerable size though, even in these, the nests are often scattered over a wide area. Apparently both sexes take part in incubation but they are said not to sit very close and to leave their nests on but little provocation, though they return very quickly to them when the sun is at all high.

Habits.—The Habits of the Pratincoles are very similar to those of the Coursers. They associate during the non-breeding season

in small flocks which may generally be seen running about on the ground, or at other times wheeling and twisting about in rapid flight close above it. Whether running or flying, they always seem to be in a hurry and the energy they display is very great. At the same time they move about but little during the hottest hours of the day, though even during these they seldom seek the shelter of shade of any kind. Their favourite country is some bare and barren dark-coloured waste land or deserted patches of cultivation but, though they never enter forest or even thin scrub, they may often be seen in cultivated fields and thin short grassland. They are wary birds and difficult to approach within shot. Their food consists almost entirely of various insects, though sandhoppers, small grasshoppers and locusts probably form the great part of it.

Glareola maldivarum maldivarum

The Large Indian Pratincole or Swallow-Plover

Glareola maldivarum Forster, Fauna Indica, p. 11 (1795) (Maldive Is.)

Glareola orientalis.—Blanf. and Oates, iv, p. 214.

Vernacular Names.—None recorded.

Description.—Differs from the preceding bird in being much darker both above and below and in having comparatively less white on the tail. The tail itself is much shorter and much less deeply forked.

Colours of soft parts as in *G. pratincola*.

Measurements.—Wing 173 to 191 mm.; tail, longest outermost feathers 71 to 85 mm.; shortest central feathers 52 to 62 mm.; tarsus 30 to 33 mm.; culmen 13 to 15 mm.

Nestling.—'Greyish-buff down, much mottled with dark blackish-brown spots.' (Butler).

Distribution.—India, Ceylon, Burma, the Indo-Chinese Countries to Eastern Siberia and the Malay Peninsula and Archipelago. Mathews accepts Leach's *orientalis* as a subspecies occurring from Java Eastwards.

Nidification.—The nidification of this bird varies but little from that of the preceding but, both in Assam and in Burma, its favourite breeding haunts are grass-lands and rice-fields which have been burnt, where the little chips of half-burnt stalks of rice or grass speckle the black earth with yellow and make the eggs extraordinarily difficult to detect. In Burma both Hopwood and Mackenzie found them breeding on the banks of small islands in muddy creeks and, in Assam, I have also taken their eggs on the edges of mustard cultivation, where the village cattle and buffaloes have trampled the crops out of existence. Apparently this Pratincole always breeds in colonies which may number anything from half a dozen to fifty or more pairs. Sometimes, too, with this species the nests are placed close together not more than two or three yards apart, though sometimes they may be as much as fifty yards distant from one another. They are said to be much closer sitters than the European Pratincole and to refuse to leave their eggs until the intruder is very close, when they frequently move away

feigning illness, in the hopes of drawing the intruder away from the nest. It is very interesting too, to note that these actions cannot be caused, as Dewar would have us believe, by uncontrollable fright, for very often when the bird's first efforts to entice the intruder away have failed, it will again return and make renewed attempts. This can easily be proved if a person on finding a nest, moves away from it and then, as soon as the parent bird ceases its antics, once more walks towards the eggs, when the pretence of being wounded or ill will once more be acted by the bird. It is not unusual for these manœuvres to be repeated again and again long after the effect of the first sudden fright must have passed away, and they certainly seem to show a certain amount of reasoning power on the part of the parent bird. The eggs are quite undistinguishable from those of the preceding bird but perhaps average a trifle lighter. Sixty eggs average 30·8 by 23·9 mm.; maxima **34·2** by **25·3** mm.; minima **28·0** by 22·5 mm. and 31·4 by **21·4** mm.

Habits.—These differ in no way from those of the Collared Pratincole but, whereas that bird sometimes breeds year after year in the same locality, the nesting places of the Indian bird seem to be frequently changed, although the change may be only temporary. When I was in Assam there were several fairly large flocks to be found in the dark soil above the sand limit of the larger rivers. For two or three years these birds would haunt and breed in one particular spot and then, for no obvious reason, desert it completely and move out of the district altogether, returning perhaps after a lapse of some four or five years. They are distinctly less shy birds than the preceding and, provided the watcher keeps very still, they will sometimes allow an observation from a very short distance. A curious habit I noticed with this little Pratincole was that of scratching in the soil rather like a small game bird, and this they do both when they feed and when dusting themselves. The stomachs of those birds which I examined were nearly always full of very small grasshoppers and their larvae, but one bird contained a mass of tiny beetles and another contained what looked like a mass of flying ants.

Glareola lactea

The Small Indian Pratincole or Sand-Plover

Glareola lactea Temm., Man. d'Orn., ed. ii. 2, p. 503 (1820) (Bengal); Blanf. and Oates, iv, p. 216.

Vernacular Names.—None recorded.

Description.—Lores and a line round the front of the eye velvet-black; whole upper plumage pale grey, faintly tinged sandy and browner on the forehead; scapulars, inner secondaries, lesser and median wing-coverts sandy-grey, the last tipped white; greater and primary coverts black; primaries black, all but the first two or three with a patch of white on the outer webs of the innermost; secondaries white with black tips, broadest on the first, narrowest

on the inner; upper tail-coverts white; tail white with a very broad subterminal black band; chin, throat, fore-neck and upper breast sandy-buff changing to pale grey on the breast and flanks; under wing-coverts and axillaries black; remainder of lower plumage white.

Colours of soft parts.—Iris dark brown; bill black, red at the base and more yellow on the gape; legs and feet dark brown or plumbeous to black.

Measurements.—Wing 142 to 160 mm.; tail 50 to 57 mm.; tarsus 20 to 21 mm.; culmen 9 to 10 mm. Siamese and Burmese specimens are very small, wing 136 to 149 mm, and seem slightly greyer, less sandy, in colour but there is so much overlapping both in size and colour that I hesitate to separate them.

Young Birds have the feathers of the upper plumage obsoletely edged paler sandy and have the throat and fore-neck spotted with blackish.

Distribution.—Ceylon, India and Burma. It occurs in Kashmir but not West of the Indus.

Nidification.—Unlike the larger Pratincoles which select black or dark coloured soil on which to deposit their eggs, this beautiful little bird invariably breeds on the banks or islands of large rivers, where the sand and shingle is the usual pale yellow or sandy grey. As a rule the birds select the higher sand ridges for the purpose of nesting but I have occasionally seen them breeding on shingle and very often the eggs may be found amongst a very thin crop of grass or *Equisetum,* whilst at other times they may be placed absolutely in the open, without any cover whatsoever. The colonies generally are of great size. Occasionally one finds a dozen or so pairs of birds breeding on a small island but most colonies number over a hundred, whilst some contain as many as three or four hundred pairs of birds. They breed not only on the great rivers of India where they flow more or less placidly through the plains but often have their nesting places in these same rivers where they debouch from the hills and where the water comes rushing and tumbling past their nesting island. Occasionally, even, I have found small colonies well inside the hills but never at a height at which the rivers dwindle in size to small streams. The birds are extraordinarily persistent in sticking to a favourite breeding haunt and I have known eggs washed out three times by the river rising and flooding, before the birds eventually moved to a higher site. When in large colonies the eggs are often placed so close together that it is very difficult to avoid stepping on them and I have seen as many as a dozen nests within a space of four square yards. Never apparently are they widely scattered as is so often the case with the larger Pratincoles in some districts in India. The normal clutch of eggs is two only, three being exceptional, though in some parts of Assam I have found four to be the normal clutch. They are deposited in small depressions scratched out by the parent birds in the sand and, though there is no lining to this, I have never seen the eggs deposited on the bare ground without a hollow being scraped for them. As we might expect from the colour of the sand and stones among which they lie, the eggs are themselves of a pale sandy buff or sandy

grey—exceptional eggs having a very faint tinge of olive-green or creamy pink. The markings consist of small primary specks and blotches of light reddish brown with other secondary ones of pale lavender or neutral tint. These are scattered fairly thickly over the whole surface but are sometimes rather more dense at the larger end. They are never thick enough or dark enough to render the general tint of the egg anything but sand colour. Two hundred eggs average 25·9 by 20·5 mm.; maxima **29·2** by 21·0 mm. and 28·5 by **22·0** mm.; minima **23·9** by 19·9 mm. and 25·7 by **19·0** mm.

Habits.—This little Pratincole seems invariably to frequent the larger rivers where there are wide stretches of sand and shingle, where they collect in flocks of many hundreds. In the winter they may also be found on the sea coast and the estuaries where the banks of the rivers are more mud than sand and throughout the Sunderbands they are extraordinarily common. The size of the flocks in which they collect can be estimated from the effects of a shot I once fired. As I only wanted to collect one or two birds out of the flock as specimens, I delayed my shot until I could fire at the last few birds passing me. Unfortunately, as I fired, the flock wheeled, so that I shot not only into the tail but into the head of the flock as well. After this shot my coolies picked up forty-two birds and many more fell or fluttered into the waters of the Megna, where the muggers who infested the river made any question of following them up utterly impossible. On the wing they certainly are one of the most beautiful and graceful of all our Indian birds. They come sweeping up to one at a tremendous pace and then without any apparent cause, suddenly wheel and twist first this way and then the other, every bird apparently actuated by the same idea at the same moment. After a few moments in the air, the birds settle in a cloud on some sandbank close to the edge of the river and one then sees each individual making tiny little spurts here and there in the pursuit of their insect food. In this way, although each bird seems to be running independently of the others, backwards and forwards, the whole flock by degrees gradually wanders up or down the river for some three or four hundred yards. Then once more, without a moment's warning the whole flock simultaneously rises and dashes off to some other feeding ground. The stomachs of those I have examined contained mainly insects and sandhoppers but I have also found small molusca, whilst in one bird there were three or four of what looked like tiny sand eels about an inch long. They follow the great Northern rivers into the Himalayas so far as these have suitable banks and islands for breeding purposes and their eggs have been taken at an elevation of nearly 6,000 feet. They are extraordinarily plump little birds, often coated with fat, and on one occasion when hard pressed for food I ate them in a pie and found them excellent, tasting almost exactly like ortolan. It is to be hoped, all the same, no one will ever consider them proper objects of sport or kill them to eat when other things are available.

(To be continued)

REVISION OF

THE FLORA OF THE BOMBAY PRESIDENCY

BY

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PART XI

GRAMINEÆ

BY

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(*Continued from page 775 of Volume XXXIII*)

KEY TO THE GENERA.

We follow, where possible, the systematic arrangement given by Stapf in the Flora of Tropical Africa. We add in brackets the reference to the genera in our series.

SUB-FAMILY I: Panicoideae.—Mature spikelets falling entire from their pedicels or with them, all alike or differing in sex and structure; perfect spikelets with two heteromorphous florets, the upper hermaphrodite, the lower male or barren; rhachilla not continued beyond the upper floret (Genera 1-61).

TRIBE I: MAYDEÆ.—Sexes in different inflorescences on the same plant, or the female spikelets at the base of the inflorescence, the male above them; spikelets never awned, the male and female very dissimilar (Genera 1-4).

1. Male and female spikelets in separate inflorescences; male spikelets in a large terminal panicle; the female spikelets in the axils of the leaves.
   - *A.* Female spikes distinct, articulated (vol. 32, 15) .. .. 1. *Euchlaena.*
   - *B.* Female spikelets grown together into a spongy more or less cylindrical body (vol. 32, 15) ... ... 2. *Zea.*
2. Male and female spikelets in separate portions of the same spike, the female below.
   - *A.* Grain enclosed in the usually globose or ovoid ivory-like capsuliform supporting sheath (vol. 32, 17) ... ... 3. *Coix.*
   - *B.* Grain enclosed in the hardened outer glumes (vol. 32, 17) ... ... 4. *Polytoca.*

TRIBE II: ANDROPOGONEÆ.—Spikelets usually in pairs, one sessile, the other pedicelled, very rarely both pedicelled, those of each pair alike as to sex (homogamous) or different (heterogamous), rarely 3-nate or solitary on the axis of a usually spike-like raceme. Involucral glume more or less rigid and firmer than the floral glumes, the lower always

longer than the florets; floral glumes membranous, often hyaline, that of the upper floret usually awned or reduced to an awn (Genera 5–41).

1. SUB-TRIBE: *Dimerinæ.*—Spikelets homogamous, second on a slender inarticulate rhachis, 1-flowered, diandrous (vol. 32, 18) ... ... 5. *Dimeria.*
2. SUB-TRIBE: *Ischæminæ.*—Fertile spikelets 2-flowered; fertile floret awned from the sinus of the bifid or bidentate upper floral glume, sometimes awnless in *Apluda* (Genera 6–13).
   - *A.* *Group Ischæmastræ.*—Racemes several- to many-noded, espatheate; spikelets of each pair homogamous or more often heterogamous, usually similar in shape and nervation, rarely distinctly heteromorphous; fertile spikelets awned (Genera 6–12).
     - *i.* Margins of lower involucral glume of sessile spikelet inflexed.
       - *a* Stem not woolly below; joints and pedicels stout; spikelets heterogamous (Genera 6–8).
         - (1) Spikes clustered; lower involucral glume not channelled (vol. 32, 19)... 6. *Ischæmum.*
         - (2) Spikes solitary; lower involucral glume usually channelled (vol. 32, 22) ... ... 7. *Sehima.*
       - *b.* Rootstock and base of stem clothed with woolly sheaths; spikelets similar and homogamous (vol. 32, 25) ... 8. *Pollinidium.*
     - *ii.* Margins of lower involucral glume of sessile spikelet not inflexed.
       - *a.* Spikes solitary; spikelets 2-nate, 1-2-flowered, 2-awned (vol. 32, 289) ... 9. *Pogonatherum.*
       - *b.* Spikes solitary or 2-nate; spikelets 2-flowered, diandrous; lower involucral glume very broad truncate (vol. 32, 25) ... ... 10. *Apocopis.*
       - *c.* Spikes digitate; spikelets 2-flowered; lower involucral glume tubercled (vol. 32, 22) ... ... 11. *Thelepogon.*
       - *d.* Spikes 2-∞-nate; spikelets 2-nate, upper alone awned (vol. 32, 25) ... 12. *Lophopogon.*
   - *B.* *Group Apludastræ.*—Racemes 1-noded, reduced to 3 heteromorphous spikelets, the sessile with a male and a hermaphrodite floret and an inflated callus, one pedicelled with 2 male florets, the other rudimentary on a glume-like pedicel; fertile florets awned or awnless (vol. 32, 26) ... ... 13. *Apluda.*
3. SUB-TRIBE: *Rotboellinæ.*—Fertile spikelets 1- or 2-flowered; fertile florets awnless (Genera 14–21).

   Group Rotboelliastræ.—Racemes at the ends of the culms and their branches in a false (rarely true) spatheate panicle or solitary and terminal on simple or sparingly branched culms.
   - *A.* Spikelets all alike, also as to sex; racemes tough or tardily disarticulating, much compressed, joints and pedicels fused (vol. 32, 26) ... ... 14. *Hemarthria.*

B. Spikelets of each pair more or less dissimilar, at least as to sex, the pedicelled male, neuter or suppressed (Genera 15–21).

i. Sessile spikelets small, globose, foveolate, 1-flowered, pedicelled very dissimilar; joints and pedicels fused (vol. 32, 28) ... 15. *Manisuris.*

ii. Sessile spikelets not globose (Genera 16–21).

a. Sessile spikelets winged from the transversely rugose or muricate lower involucral glumes, 1-flowered, pedicelled very dissimilar; joints and pedicels fused (vol. 32, 29) ... 16. *Peltophorus.*

b. Sessile spikelets not winged (Genera 17–21).

(1) Racemes usually more or less villous, very rarely glabrous, never cylindrical, joints and pedicels moderately stout, gaping.

i. Spikelets 2-flowered, very villous all over, the sessile sometimes 2 at a node and sub-opposite (vol. 32, 30) 17. *Lasiurus.*

ii. Spikelets 1-flowered; racemes more or less villous from the joints and pedicels or the edges of the spikelets, rarely glabrous; lower involucral glume with a transparent oil-duct inside each keel or a fringe of penicillate warts (vol. 32, 30) ... 18. *Elyonurus.*

(2) Racemes glabrous, cylindrical, particularly when the spikelets are closed (Genera 19–21).

i. Pedicels and joints fused.

(*a*) Racemes stout, few from each culm; sessile spikelets 2-flowered, pedicelled male or neuter (vol. 32, 31) ... ... 19. *Rotboellia.*

(*b*) Racemes slender in ample spatheate panicles; sessile spikelets 1-flowered (vol. 32, 31) ... 20. *Ophiurus.*

ii. Pedicels free from the joints; racemes usually in terminal and lateral spatheate fascicles or fastigiate panicles; coarse tall grasses (vol. 32, 32) ... ... 21. *Coelorrhachis.*

4. SUB-TRIBE: *Saccharinæ.*—All spikelets alike in shape and sex, or if different in sex, then the pedicelled female (Genera 22–25).

A. Group Saccharastræ.—Racemes in more or less compound panicles or racemosely arranged on an elongated common axis; spikelets 1-flowered; awn from the sinus of the 2-dentate floral glume or from the tip of the entire valve or 0 (Genera 22–24).

i. Rhachis quite tough; racemes in spike-like or thyrsoid solitary panicles; all spikelets pedicelled, muticous (vol. 32, 281) ... ... 22. *Imperata.*

ii. Rhachis of racemes readily disarticulating.

a. Spikelets in a wide, often thyrsoid, more or less plumose and silvery panicle, 2-flowered, usually awned, rarely mucronate or awnless (vol. 32, 283) ... ... 23. *Saccharum.*

b. Spikelets in panicled racemes, 2-flowered, awned (vol. 32, 288) ... ... 24. *Spodiopogon.*

B. *Group Polliniastræ.*—Racemes digitate, rarely solitary; spikelets 1–2-flowered; awn from the sinus of the 2-fid or 2-dentate floral glume; spikelets dorsally compressed; callus short, obtuse (vol. 32, 289) ... ... 25. *Eulalia.*

5. SUB-TRIBE: *Andropogoninæ.*—Spikelets of each pair different in sex and frequently also in shape and size, or if those of some pairs of a raceme are alike in sex, then both male or neuter; fertile spikelets 1-flowered (Genera 26–41).

A. Racemes in more or less compound espatheate panicles; pedicels without a translucent middle line (Genera 26–29).

Group Sorghastræ.—Pedicelled spikelets male, neuter or suppressed (including the pedicel in *Cleistachne*); awn from the sinus of the 2-fid floral glume.

i. Spikelets dorsally compressed, at least when in flower; lower involucral glume of the fertile spikelets firmly chartaceous to coriacous.

a. Spikelets in threes, one of them fertile, or in racemes of 2–8 pairs; the pedicelled male, neuter, or if quite suppressed, then at least the pedicels present (vol. 32, 290) ... ... 26. *Sorghum*

b. Spikelets solitary (vol. 32, 408) ... 27. *Cleistachne.*

ii. Spikelets laterally more or less compressed.

a. Racemes of many pairs of spikelets; primary branches of panicles in whorls of 6–20 (vol. 32, 408) ... 28. *Vetiveria.*

b. Racemes usually reduced to 1 sessile hermaphrodite and 2 pedicelled male or barren spikelets, rarely of 2 or more but always few pairs (vol. 32, 410) ... ... 29. *Chrysopogon.*

B. Racemes not in compound espatheate panicles or if so (*Capillipedium*), then the pedicels with a translucent middle line (Genera 30–41).

i. Fertile floral glume awned from low down on the back.

Group Arthraxonastræ.—Sessile spikelets convex on the back and rounded on the sides, often muriculate, particularly along the sides; pedicelled usually rudimentary or 0, rarely male; racemes digitate (vol. 32, 416) ... ... 30. *Arthraxon.*

ii. Fertile florel glume awned from the sinus of a 2-fid or 2-dentate valve or continuing the more or less stipitiform floral glume (Genera 31–41).

a. Margins of the lower involucral glume of the fertile spikelet inflexed and the glume therefore sharply 2-keeled more or less all along with a short obtuse callus, rarely the keels rounded off downwards with the margins subinvolute, but then the

back of the glume deeply sunk between the keels and the callus short or long and acute; awn glabrous or scabrid, very rarely hirsute (*Andropogon* sp.); spikelets awned (Genera 31–37).

(1) Awn forming a continuation of the stipitiform fertile floral glume.

Group Amphilophiastræ.—Racemes digitate or racemosely digitate, and then usually very numerous, all more or less peduncled on simple or almost simple culms, or solitary at the end of the culms and their branches and sometimes gathered into a scanty spatheate false panicle, rarely in compound espatheate panicles (*Capillipedium*) (Genera 31–34).

i. Racemes in compound espatheate panicles (vol. 32, 419) ... 31. *Capillipedium.*

ii. Racemes not in compound espatheate panicles (Genera 32–34).

(*a*) Racemes digitate, or many racemosely arranged on a common axis shorter than the raceme.

A. Sessile spikelets of all pairs hermaphrodite, awned (vol. 32, 420) ... ... 32. *Amphilophis.*

B. Sessile spikelets of the lowest 1–3 or 4 pairs male or neuter and awnless (vol. 32, 424) ... 33. *Dichanthium.*

(*b*) Racemes solitary at the ends of the culms and branches (vol. 33, 426) ... ... 34. *Eremopogon.*

(2) Awn from the sinus of the 2-fid or 2-dentate fertile floral glume (Genera 35–37).

i. *Group Schizachyriastræ.*—Racemes solitary at the ends of the culms and their branches, the branches usually gathered into a narrow, lax, spatheate, false panicle; joints and pedicels thickened upward; pedicelled spikelets male, neuter or suppressed (vol 32, 428) ... 35. *Schizachyrium.*

ii. *Group Andropogonastræ.*—Racemes 2-nate at the end of simple or almost simple culms or gathered into spatheate false or true panicles.

(*a*) Racemes 2-nate on a slender peduncle arising from a flattened spathe; sessile spikelets alike in sex and form; joints opaque (vol. 32, 429) ... ... 36. *Andropogon.*

(*b*) Racemes 2-nate, with a spathe supporting or surrounding each pair, gathered into often much decompound spatheate panicles; the lowest pair of one of the racemes homogamous, male or neuter; all pairs of the other heterogamous; mostly aromatic grasses (vol. 32, 429) ... 37. *Cymbopogon.*

b. Margins of the lower involucral glume of the fertile spikelets involute, inflexed and 2-keeled (if at all) only close to the tips, the spikelets, therefore, with rounded sides or quite terete; callus elongate and acute or pungent; awn more or less hirsute, from the stipitiform floral glume (Genera 38–41).

(1) *Group Heteropogonastræ.*—Racemes many-noded, solitary; all pairs of spikelets heterogamous and alike or the lowest 1-many homogamous and barren, very different from the fertile, not forming an involucre around them (vol. 32, 622) 38. *Heteropogon.*

(2) *Group Themedastræ.* — Racemes fasciculiform, solitary at the apex of the stem and branches. Spikelets dimorphic, the 4 lower sessile forming an involucre round the upper.

i. Rhachis articulate below the involucral spikelets (vol. 32, 626) ... 39. *Iseilema.*

ii. Rhachis articulate above the involucral spikelets (vol. 32, 627) ... 40. *Themeda.*

(3) *Group Pseudothemedastræ.*—Like *Themedastræ* above but without the involucrant spikelets of that group (vol. 32, 631) ... ... 41. *Pseudanthiria.*

TRIBE III: PANICEÆ.—Spikelets in usually continuous spikes, racemes or panicles Involucral glumes herbaceous or membranous, the lower generally smaller, very small or suppressed. Lower floral glume generally resembling the involucral glumes in structure and nervation, the upper fertile firmer, at length rigid, often chartaceous or crustaceous, awnless, very rarely mucronate (*Urochloa*) (Genera 42–61).

1. SUB-TRIBE: *Panicinæ.*—Upper floret only fertile; lower floral glume usually resembling the upper involucral glume, not indurated (Genera 42–60).

A. Undershrubs; flowers dioecious.

Group Spinificastrææ:—Male spikelets 2-flowered, articulate in rigid umbellate spikes; female in large globose heads of stellately spreading quill-like rhachis, one spikelet at the base of each (vol. 33, 21) ... ... 42. *Spinifex.*

B. Herbs; flowers not dioecious (Genera 43–60).

i. *Group Digitariastræ:*—Inflorescence of usually slender, spiciform, digitate or subdigitate or somewhat distant, very rarely solitary racemes; fruiting floral glume with usually flat, thin to hyaline margins, thinly cartilaginous, often brown or dark, with the usually minute, often microscopic, scale-like pale of the barren floret attached to the base.

a. Spikelets awnless; lower involucral glume minute, rarely **0**; lower floral glume usually with 5–7 close, straight, prominent nerves (vol. 32, 632) ... 43. *Digitaria.*

b. Spikelets slender awned (vol. 32, 635). 44. *Alloteropsis*.

ii. Inflorescence usually different (but see *Axonopus* and *Paspalum*); fruiting floral glume with more or less inrolled margins, usually crustaceous and straw-coloured or whitish; pale of the barren floret, if developed, not attached to the false fruit (Genera 45–60).

a. Spikelet falling entire and singly from the persistent pedicels (Genera 45–58).

(1) *Group Panicastræ*:—Spikelets not awned, or if awned, then sub-sessile in false second variously arranged spikes and with the awns from the entire tips of the upper involucral glume and lower floral glume (*Echinochloa* sp.) or from the tips of both involucral glumes or at least the lower (Genera 45–57).

i. Inflorescence of variously arranged (rarely solitary) simple or compound, usually second, spike-like, dense (rarely loose) racemes, not an open or contracted and cylindric panicle; spikelets usually paired or sometimes particularly towards the base of the raceme in fascicles of 3 (rarely more) unequally pedicelled or solitary, alternately to the right and the left of the median line of a usually dorsiventral rhachis; fruit dorsally (very rarely laterally) compressed, its glume and pale crustaceous; racemes usually rather dense (Genera 45–52).

(*a*) Back of fruit abaxial (Genera 45–47).

A. Spikelets strongly laterally compressed, distant on long slender rhachises; lower involucral glume herbaceous, as long as the spikelet (vol 33, 7) .. .. 45. *Pseudechinolæna*.

B. Spikelets more or less dorsally compressed; lower involucral glume never herbaceous.

(*i*) Lower involucral glume rudimentary with a swollen annular callus at the base of the rhachilla; fruit mucronate (vol. 32, 636) ... 46. *Eriochloa*.

(*ii*) No swollen annular callus at the base of the spikelet. Lower involucral glume present; racemes racemosely arranged (vol. 32, 636). 47. *Brachiaria*.

(*b*) Back of the fruit adaxial (Genera 48–52).

A. Lower involucral glume typically absent; spikelets usually conspicuously planoconvex, with the flat side turned away from the rhachis (vol. 32, 639) ... ... 48. *Paspalum*.

B. Lower glumes developed; rhachis persisting, not articulate; spikelets falling from the pedicels (Genera 49–52).

(*i*) Involucral glumes neither awned nor caudate; if shortly cuspidate-acuminate, then the fruiting floral valve obtuse with an imposed

mucro and the margins inrolled all along.

* Fruiting flowering glume acute, not mucronate; spikelets solitary, closely biseriate, contiguous with their sides; false spikes rigid, not several times longer than the internodes of the long common axis; their lower parts more or less appressed to the alternately hollowed out flanges of the latter (vol. 32, 641) ... 49. *Paspalidium.*

** Fruiting flowering glume obtuse, abruptly mucronate or aristulate; spikelets solitary or paired, when solitary contiguous with their backs; false spikes often flexuous or curved, usually several times longer than the internodes of the relatively short common axis, spreading from the base (vol. 32, 642) ... 50. *Urochloa.*

(*ii*) Glumes caudate-or cuspidate-acuminate or awned.

* Glumes awned from the entire acute or acuminate tip, or caudate or cuspidate-acuminate; margins of the fruiting flowering glume flat upwards, not embracing the tip of the pale; racemes dense, more or less secund, often very numerous (vol. 32, 645) ... ... 51. *Echinochloa.*

** Glumes awned from the slightly notched tips; racemes elongated or short to very short, secund, compact, spreading from the common axis (vol. 33, 8) ... ... 52. *Oplismenus.*

ii. Inflorescence an open panicle, rarely contracted, cylindrical and spike-like (*Sacciolepis*, *Setaria* sp.) (Genera 53–57).

(*a*) Spikelets not supported by bristle-like branches (Genera 53–56).

A. Spikelets not gibbous or, if slightly so, then not in cylindrical false spikes (Genera 53–55).

(*i*) Branches of panicle not adnate to the main axis.

* Panicle much contracted, dense, very compound, with erect narrowly lanceolate spikelets; lower floral glume beaked, upper floral glume rather thin (vol. 33, 15)... 53. *Hymenachne.*

** Panicle usually open; lower floral glume not beaked, upper floral glume crustaceous (vol. 33, 9) ... ... 54. *Panicum.*

(*ii*) Branches of panicles more or less adnate to the main axis so that the pedicels appear to spring more or less directly from the axis (vol. 33, 17) ... ... 55. *Sacciolepis.*

B. Spikelets distinctly gibbous, laterally much compressed (vol. 33, 16) ... 56. *Cyrtococcum.*

(*b*) All the spikelets or only the upper of each branch supported by bristle-like branches (vol. 33, 19) ... ... 57. *Setaria.*

(2) *Group Meliniastræ.*—Spikelets finely awned or mucronate from the notched tips of the upper involucral glume and barren floral glumes (or if muticous, these at least slightly notched) delicately pedicelled, panicled; lower involucral glume very minute. Upper involucral glume and barren floral glume gibbous at or below the middle, both 5-nerved; nerves hidden by copious and long silky hairs and anastomosing below the obtuse tips (vol. 33, 21) ... ... 58. *Tricholaena.*

b. Spikelets falling in groups or if singly, then surrounded by an involucral of bristles or at least supported by 1 to several bristles.

Group Cenchastræ.—Spikelets falling by an involucral of bristles or spines or bract-like scales, or at least supported by 1 to several bristles; or with the lower involucral glumes of each group forming a false involucre

(1) Involucre of free naked or plumose bristles (vol. 33, 22) ... ... 59. *Pennisetum.*

(2) Involucres of spines or rigid bristles united at the base into a hard cup (vol. 33, 229) ... ... 60. *Cenchrus.*

2. SUB-TRIBE: *Isachninæ.*—Both florets fertile, or if the lower male, then its floral glume more or less resembling that of the upper floret and indurated.

Group Isachnastræ.—Florets very similar, spikelets more or less panicled (vol. 33, 230). 61. *Isachne.*

SUB-FAMILY II: Pooideae.—Mature spikelets breaking up, leaving the persistent or subpersistent glumes on the pedicel, or if falling entire, then not consisting of 2 heteromorphous florets as in Panicoideæ (Genera 62–109).

1. Blades not articulated on the sheath, rarely (*Centotheca*) transversely veined (Genera 62–104)

A. Awn of the fertile floret, if present, kneed and twisted below the knee, or straight in reduced forms (Genera 62–78).

i. Florets 2 or more (Genera 62–69).

TRIBE IV: ARUNDINELLEÆ.—Florets 2, heteromorphous, the lower awnless, or barren. Rhachilla not continued beyond the upper floret. Lower floral glume awnless, rather resembling the involucral glumes; upper generally awned, at length firm or hard: awn from sinus between 2, sometimes minute or bristle-like, lobes, rarely from the entire obtuse tip, usually kneed and twisted below the knee.

a. Upper floral glume 2-setose, minutely 2-toothed or entire; awn sometimes reduced (vol. 33, 230) ... ... 62. *Arundinella.*

b. Upper floral glume always distinctly 2-toothed or 2-lobed; awn always kneed; spikelets in clusters of 3 (vol. 33, 234) ... ... 63. *Tristachya.*

TRIBE V: AVENEÆ.—Florets 2-many, all alike, except the uppermost which often are reduced. Floral glumes with hyaline shining margins or

firmer, 5-or more nerved, rarely 3-nerved; awn, if present, from the back or sinus or between bristles,

a. Floral glumes awnless or awned from the back; florets 2 or more, the uppermost reduced.

(1) Spikelets 2- or more-flowered, awned (vol. 33, 234) ... ... 64. *Avena*.

(2) Spikelets 2-flowered, awnless (vol. 33, 235) ... ... 65. *Coelachne*.

b. Floral glumes awned from the sinus of the bifid tip; florets 3 to many, the uppermost reduced (vol. 33, 236) ... 66. *Danthonia*.

TRIBE VI: ARUNDINEÆ.—Florets 2-many, enveloped in very long hairs, springing either from the callus or from the back or margins of the floral glumes.

a. Hairs springing from the margins of the upper floral glume (vol. 33, 234). 67. *Thysanolaena*.

b. Hairs springing from the callus (vol. 33, 236) ... ... 68. *Phragmites*.

c. Hairs springing from the involucral glumes (vol. 33, 237) ... ... 69. *Arundo*.

ii. Florets 1 (Genera 70–78).

TRIBE VII: AGROSTEÆ.—Floret 1. Rhachilla rarely produced beyond the floret; upper floral glume membranous, not changed when mature, usually 5-nerved, all the nerves or the outer side-nerves often slightly excurrent, parallel or at least not anastomosing. Spikelets awned or not.

a. Spikelets in cylindric spike-like panicles, not awned (vol. 33, 237) ... 70. *Heleochloa*.

b. Spikelets in open or contracted many-flowered panicles, awned.

(1) Involucral glumes acuminate or awned (vol. 33, 238) ... ... 71. *Garnotia*.

(2) Involucral glumes awned from the notched or lobed tips (vol. 33, 237)... 72. *Polypogon*.

TRIBE VIII: STIPEÆ.—Floret 1. Rhachilla not produced beyond the upper floral glume which is bisexual, hardened when mature, tightly enveloping the fruit; nerves joining or closely approaching at the tip. Awn terminal, rarely absent.

Awns 3, from the entire tip, or 1, simple below and 3-branched above, very rarely quite simple (vol. 33, 238) ... ... 73. *Aristida*.

TRIBE IX: ZOYSIEÆ.—Floret 1. Mature spikelets falling entire and singly, or in clusters. Rhachilla not continued beyond the floret. Involucral glumes equal or the lower much smaller or suppressed. Floral glume small, delicately membranous, 3-1-nerved; spikelets in slender spiciform panicles or racemes (Genera 74–78).

a. Spikelets falling in clusters of 2–4, fascicled.

(1) Fascicles secund on a broad articulate rhachis; glumes 4; upper involucral glume not echinate (vol. 33, 480) ... ... 74. *Trachys*.

(2) Fascicles all round a slender rhachis; glumes 3; upper involucral glume echinate (vol. 33, 480)... 75. *Nazia*.

b. Spikelets falling singly.

(1) Lower involucral glume with pectinate margins; upper involucral

glume spinulosely tuberculate: glumes 3 (vol. 33, 481) ... 76. *Latipes.*

(2) Involucral glumes neither pectinate nor tuberculate.

i. Glumes 2; spikelets not awned (vol. 33, 481) ... ... 77. *Osterdamia.*

ii. Glumes 3; spikelets with a long awn (vol 33, 481) ... ... 78. *Perotis.*

B. Awn of the fertile floret, if present, never kneed and twisted below the knee (Genera 79–104).

(*i*) Floral glumes typically 3-nerved (Genera 79–94).

TRIBE X: SPOROBOLEÆ.—Floret 1. Involucral and floral glumes very similar; rhachilla not or rarely produced beyond the floret. Upper floral glumes membranous, acute or obtuse, not changed when ripe, 1-or more or less distinctly 3-nerved, awnless, usually olive-green or grey; side-nerves, if present, delicate, evanescent above. Seed often free in the delicate pericarp.

Spikelets small (vol. 33, 482) ... 79. *Sporobolus.*

TRIBE XI: ERAGROSTEÆ.—Florets usually numerous and far exserted from the glumes. Spikelets variously panicled, sometimes spicate or subspicate; involucral and floral glumes somewhat similar in general appearance; floral glumes membranous or chartaceous, entire or 2-3-cleft, 3-nerved, the nerve evanescent above or excurrent into bristles; side-nerves usually submarginal, glabrous or pubescent or finely ciliate below; pales often persistent or subpersistent (Genera 80–84).

a. Floral glumes entire (Genera 80–83).

(1) Upper involucral glume 3-nerved (vol. 33, 486) ... ... 80. *Eragrostis.*

(2) Upper involucral glume 5-nerved (vol. 33, 495) ... ... 81. *Halopyrum.*

(3) Upper involucral glume 1-nerved.

i. Floral glumes ovate subacute or obtuse (vol. 33, 495) ... 82. *Leptochloa.*

ii. Floral glumes acute or acuminate (vol. 33, 486) ... ... 83. *Desmostachya.*

b. Floral glumes toothed (vol. 33, 495)... ... ... 84. *Diplachne.*

TRIBE XII: CHLORIDEÆ.—Florets 1 to many. Spikelets usually in 2-ranked secund spikes or spike-like racemes, rarely distinctly pedicellate and paniculate; floral glumes usually membranous, truncate, emarginate or toothed, 3-nerved; nerves distant, subparallel, distinct, percurrent or excurrent, and often ciliate all along, the lateral submarginal (in *Eleusine* there are sometimes additional side-nerves close to the middle nerve of the glume). Awn, if present, straight, usually from a truncate or toothed tip (Genera 85–94).

a. Floral glumes entire, emarginate or more or less 2-dentate or 2-lobed, muticous or with the middle-nerve running out into an awn or mucro, or reduced in some species of *Tripogon* (Genera 85–93).

(1) Spikelets 1-flowered (genera 85–88).

i. Spikes solitary, terminal (see also *Chloris*) (genera 85–87).

(*a*) Spikelets minute, more or less sunk in the rhachis, 1-3-flowered (vol. 33, 753) ... ... 85. *Oropetium.*

(*b*) Spikelets not sunk in the rhachis

A. Spikelets awnless, minute, unilateral on flattened rhachis, 1-flowered (vol. 33, 753) ... 86. *Microchloa.*

B. Spikelets awned, 1-2-flowered in deciduous articulate clusters (vol. 33, 754) ... ... 87. *Gracilea.*

ii. Spikes digitate (vol. 33, 753) ... 88. *Cynodon.*

(2) Spikelets with several florets (Genera 89–93).

i. Spikelets with 1 (rarely 2, *Chloris* sp.) fertile and 1 or several imperfect florets above or below the fertile (see also *Microchloa*).

(*a*) Spikelets in long secund solitary spikes; floral glumes narrow, firm, glabrous or scaberulous, with a short erect awn from the notched or subentire tips (vol. 33, 755) ... ... 89. *Enteropogon.*

(*b*) Spikelets in digitate, rarely solitary or 2-nate spikes; the florets much widened upwards, or if narrow, then delicate and usually with a fine awn from below the tips, often ciliate; floral glumes or at least some of them awned, very rarely submuticous (vol. 33, 755) ... 90. *Chloris.*

ii. Spikelets with 2 or more fertile florets and without imperfections below them (See also *Chloris* sp.); floral glumes awnless or with a rigid mucro or very short awn from the acuminate tips (*Dactyloctenium* sp.), entire or subentire (Genera 91–93).

(*a*) Spikelets in digitate or subdigitate spikes.

A. Spikes terminated by a spikelet; involucral and floral glumes emucronate or obscurely mucronate (vol. 33, 761) .. 91. *Eleusine.*

B. Spikes terminating with a sharp point; upper involucral glume and floral glumes rigidly mucronate or shortly awned (vol. 33, 760) ... ... 92. *Dactyloctenium.*

(*b*) Spikelets in racemosely arranged spreading or deflexed, finally deciduous spikes (vol. 33, 763)... 93. *Dinebra.*

b. Floral glumes variously toothed or lobed with the middle and side-nerves running out into awns or mucros.

Spikes solitary and terminal on the culms; spikelets mostly olive-green or dark greyish; all 3 nerves or at least the middle-nerve running out into a fine short awn or mucro (vol. 33, 764) ... 94. *Tripogon.*

(*ii*) Floral glumes 5 to many-nerved, very rarely 3-nerved (genera 95–104).

TRIBE XIII: PAPPOPHOREÆ.—Floral glumes broad 5-many-nerved, cleft into 3-many subulate lobes,

with or without alternating fine straight awns from the sinuses.

Floral glumes 9-cleft (vol. 33, 766) ... ... 95. *Enneapogon.*

TRIBE XIV: ORYZEÆ.—Spikelets all alike or more or less heteromorphous and unisexual. Fertile Floret 1, awned or not, terminal with 2 minute empty florets (floral glumes) below it or solitary. Involucral glumes very minute or confluent into an annular rim or suppressed; pale 3-9-nerved; stamens usually 6, rarely more, or 1–3.

a. A floating glabrous grass; spikelets awned (vol. 33, 769) ... ... 96. *Hygrorhiza.*

b. Leafy tall grasses, not floating; spikelets usually awnless.

(1) Keels of floral glume and pale pectinately ciliate; spikelets awnless (vol. 33, 768) ... ... 97. *Homalocenchrus.*

(2) Keels of floral glume and pale not pectinately ciliate; spikelets rarely awned (vol. 33, 767) ... ... 98. *Oryza.*

TRIBE XV: FESTUCEÆ.—Involucral glumes more, or less resembling the floral ones in general appearance. Fruiting florets 2 to many, very rarely 1, often much exserted from the glumes. Floral glumes 5-or more-nerved (rarely 1-3-nerved). Awns, if present, terminal or subterminal, never geniculate.

a. Leaves narrow, not tessellately nerved; fruiting glumes without submarginal bristles.

(1) Leaves reaching 30 cm. long or more, flaccid; inflorescence in long, often interrupted cylindric spikes (vol. 33, 769) ... ... 99. *Elytrophorus.*

(2) Leaves less than 5 cm. long, rigid, pungent; inflorescence in short subcapitate spikes (vol. 33, 769)... 100. *Aeluropus.*

b. Leaves broad, tessellately nerved; fruiting glumes with reflexed submarginal tubercle-based bristles (vol. 33, 770) ... ... 101. *Centotheca.*

TRIBE XVI: HORDEÆ.—Spikelets sessile, singly or in clusters, more or less sunk in the hollows of the rhachis of a simple spike; florets 1 or more.

a. Spikelets solitary at the nodes of the spike.

(1) Spikelets with their median plane radial to the rhachis; florets 1–2; floral glumes membranous to subhyaline, 3-nerved (vol. 33, 770) ... 102. *Lepturus.*

(2) Spikelets with their median plane tangential to the rhachis; floral glumes more or less ventricose, keeled upwards, 5-9-nerved (vol. 33, 770) ... ... 103. *Triticum.*

b. Spikelets in groups of 3 at the nodes of a dense spike; floral glumes 5-nerved (vol. 33, 771) ... ... 104. *Hordeum.*

2. Blades articulate on the sheath and transversely veined.

TRIBE XVII: BAMBUSEÆ.—Shrubs or trees; spikelets all of one kind; florets few to many (rarely 1); lower 2 or more glumes empty, gradually increasing in size up to the flowering, with sometimes small terminal imperfect ones; floral glumes subherbace-

ous to subcoriaceous, 5 to many-nerved, usually awnless; lodicules usually 3; stamens 3–6 or more; styles 2 or 3 (genera 105–109).

A. Pericarp thin, adnate to the seed.

i. Pales all 2 to keeled; stamens 6; filaments free (vol. 33, 771) ... ... 105. *Bambusa.*

ii. Pales of upper flowers 0 or glume-like, not keeled; filaments connate (vol. 33, 773).. 106. *Oxytenanthera.*

B. Pericarp fleshy or crustaceous, not adnate to the seed

i. Spikelets 2 to many-flowered; pale 2-keeled; lodicules none; stamens 6; pericarp crustaceous (vol. 33, 773) ... ... 107. *Dendrocalamus.*

ii. Spikelets many-flowered; pales 2-keeled; lodicules 3, conspicuous (vol. 33, 774)... 108. *Teinostachyum.*

iii. Spikelets 1-flowered; pale absent or glume-like; stamens 6–120; pericarp fleshy (vol. 33, 774) ... ... 109. *Ochlandra.*

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THE STUDY OF INDIAN BIRDS

BY

HUGH WHISTLER, F.Z.S.

PART IV

(*With plates A, B & C and one diagram*)

(*Continued from page 792 of Vol. XXXIII*)

SOME EXTERNAL CHARACTERISTICS OF A BIRD

The Wings

All of us know that Birds and Insects are the two great classes which possess wings and in consequence attain that wonderful power of flight which has aroused the envy and emulation of man from the earliest ages. We do not all, however, realize that wings and flight have been also attained by two[1] other classes, mammals and reptiles. Curiously enough, these two classes have never reached such a universal power of flight, though some of their members which have attained to it have been able to reach as perfect a degree of proficiency as will be found in the two classes in which flying is very general.

Before discussing the wings and flight of a bird in some detail, it will be instructive to consider the methods by which flight is attained in the various classes—birds, mammals, reptiles and insects.

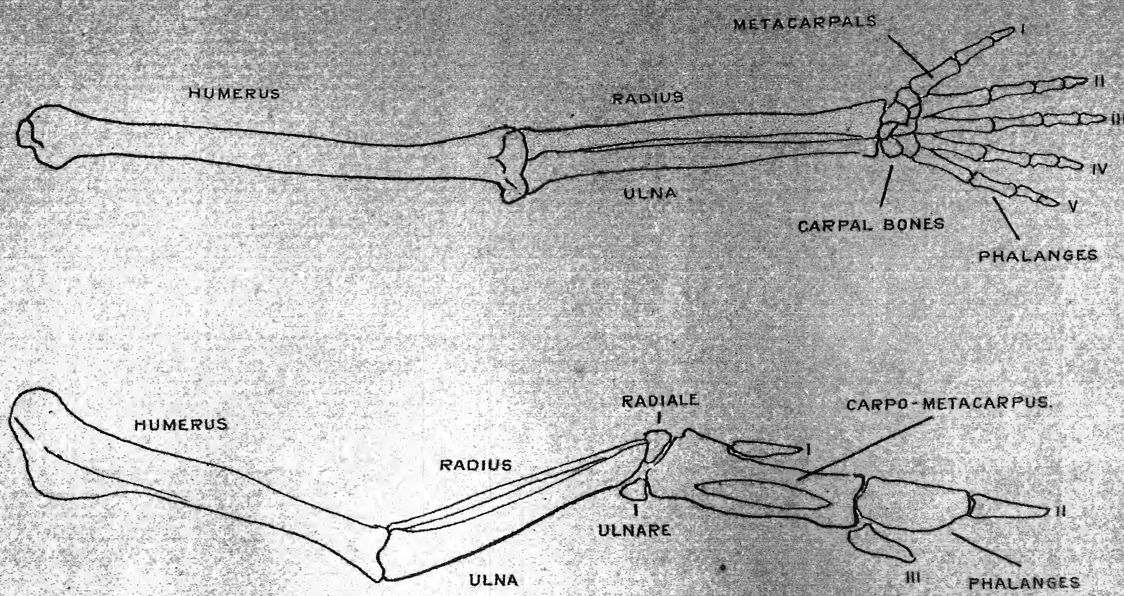
We have already seen, in discussing the origin of birds, that flight gradually evolved through the means of a patagium, a fold of skin on the forelimb which was used as a parachute. A jump into the air is the simplest means of overcoming the influence of gravity; a good 'take-off' increases the momentum and the length of a jump; and if that take-off is at a height, the length of the jump need only be limited by the jumper's power of resisting the shock entailed by the return to earth. The use of an artificial parachute is now firmly established as one of the means by which man returns to *terra-firma* from the most hazardous of heights; and the possibility that Nature could evolve her own natural parachutes in the manner postulated as a first step towards the attainment of the power of untrammelled flight is amply proved by the existence of such parachutes amongst the living animals of the world. Most of us in India are familiar with some form of flying-squirrel. The flying-squirrel shows the highest development that the parachute is capable of, simply as a parachute and without developing into something higher. These beautiful animals

[1] I do not include Fish, as the flight of the Flying-fishes does not extend beyond the limits of the principle of the parachute.

cannot fly in the true sense of the word: they are, however, able to pass through the air from tree to tree, leaping from the higher branches of one tree and sailing in a lowering and diagonal direction to the lower part of an adjacent tree. Jerdon records the fact that he once saw a Brown Flying-Squirrel thus parachute a distance of 60 yards from tree to tree. It was, he says, of course very close to the ground when it neared the second tree and the last few feet of its flight were slightly upwards. This is usual, for the momentum of the flying leap allows the squirrel to shoot upwards for the short distance necessary to allow it to grasp the tree-trunk with all four feet.

The parachute of the flying-squirrel is very simple in form and in some species would not ordinarily attract the notice of anyone who saw the animal at rest and had not previously heard of its powers. It is merely a loose lateral extension of the skin along the sides of the body which passes outwards between the limbs and terminates at the wrists and ankles. This lateral membrane is very elastic and, when the limbs are extended outwards on both sides of the body, it fills the space between them with a regular sail, so that the normal-looking squirrel becomes in flight much like a doormat—for so it once seemed to me on a Himalayan hillside when a flat red object suddenly shot through the trees down the slope in front of me. In addition to the lateral membrane, there is a narrow and inconspicuous one passing from the cheek along the front of the shoulder to the front of the wrist, and another—at least in some species—which stretches across behind the body from ankle to ankle, involving the base of the tail. Dissection shows long, osseous or cartilaginous appendages to the feet which serve to support the parachute in flight. These are interesting in view of the types of wings to be described hereafter.

Given the possibility of flight with a parachute as a beginning, the attainment of free untrammelled flight becomes merely a question of degree and method. Nature has attained it along three separate lines of development, in Bird, in Mammal and in Reptile. Yet apparently all three lines were not equally successful and represent progress by the method of trial and error. So far as the record remains for us to read, we find that the Reptile was the first to attain to flight in the full sense of the word. The Pterodactyle flew above a world in which the bird and mammal were still earth bound; but there must have been some inherent defect in that device for flight for the pterodactyles and their kind passed away leaving the reptile stock barren of a germ from which flight might anew be evolved. Then, in their turn, the Bird and the Mammal attained to flight, each on a different principle. The merits of these two principles must, however, be judged, in my opinion, by their spread. Only one order of Mammals, namely the Bats, attained to perfect flight, and very perfect indeed it is in their case, whilst amongst the Birds flight became universal. I say universal advisedly, although it is possible to mention a number of birds which are flightless. For there is little doubt in my mind, though all do not share this opinion, that the number of species now found in the world which are unable to fly have lost a power that they once had.



COMPARISON OF FORE-LIMB OF MAN AND BIRD.

Their flightlessness is due to degeneracy, through misuse or some other cause. Their ancestors shared in the common possession.

The Bird, the Mammal and the extinct Reptile all developed their powers of flight from a common starting point, the modification of the front pair of limbs into a wing. In other words, the wing in these three classes is homologous. We will proceed to examine the differences in a structure by which the three classes attained a common end. But, before doing so, we must emphasise the fact that the wing in all insects, using the word insect of course in its loose popular significance to cover a number of natural orders, is not homologous with the wing of the other three. It is merely analogous to their wing: that is to say, it fulfils a similar function. It gives the power of flight, but it has no connection with the forelimb of the vertebrates; it is an entirely different structure, with an entirely different origin, derived apparently from modifications of the gills.

There is an obvious difference between the wing of the bat and the pterodactyle and the wing of the bird. The first two depend on the original patagium or membrane skin. The latter has sacrificed the membrane and evolved the far superior feather. All three wings have evolved from the basis of a forelimb with five digits. To understand the differences, we must first pay a little attention to the structure of the forelimb.

The main features of the vertebrate forelimb are well known. Glancing down at our own, we see first of all the upper arm terminating in the elbow, then the forearm terminating in the wrist and finally the hand. The upper arm consists of a single bone known as the humerus (from which is derived that classical pun of the 'funny-bone'). The forearm consists of two bones, the ulna and the radius, two bones giving all that circular play in our forearm which is absent from the single bone of the upper arm. In bird and mammal and reptile these two main divisions of the arm with their three bones, the humerus, the ulna and the radius, persist but little altered, easily recognizable at a glance. In the wrist and hand the differences lie, just as we have already seen, in examining the origin of birds, there are differences in the corresponding parts of the hind-limbs. (See Plate A.)

The wrist and hand contain three distinct series of bones, first the carpals or wrist proper (next to the ulna and radius), then the metacarpals which form the palm and finally the phalanges which form the digits. In man the number of carpal bones is eight. I do not propose to give full details of the bones of the wrist and hand in the pterodactyle and the bat, as we are not primarily interested in them. The description of the bones of the bird's wrist and hand will follow later.

Now the pterodactyle and the bat have both retained their five digits. There is, certainly, some doubt about the first digit of the pterodactyle which is at best rudimentary, but Nos. 2, 3 and 4 are perfectly distinct and free, terminating in small curved claws. These were probably used for climbing about rocks or trees or for suspending the reptile at rest, just in the way that a bat hangs itself up to rest with the tiny claws of its feet. The fifth digit,

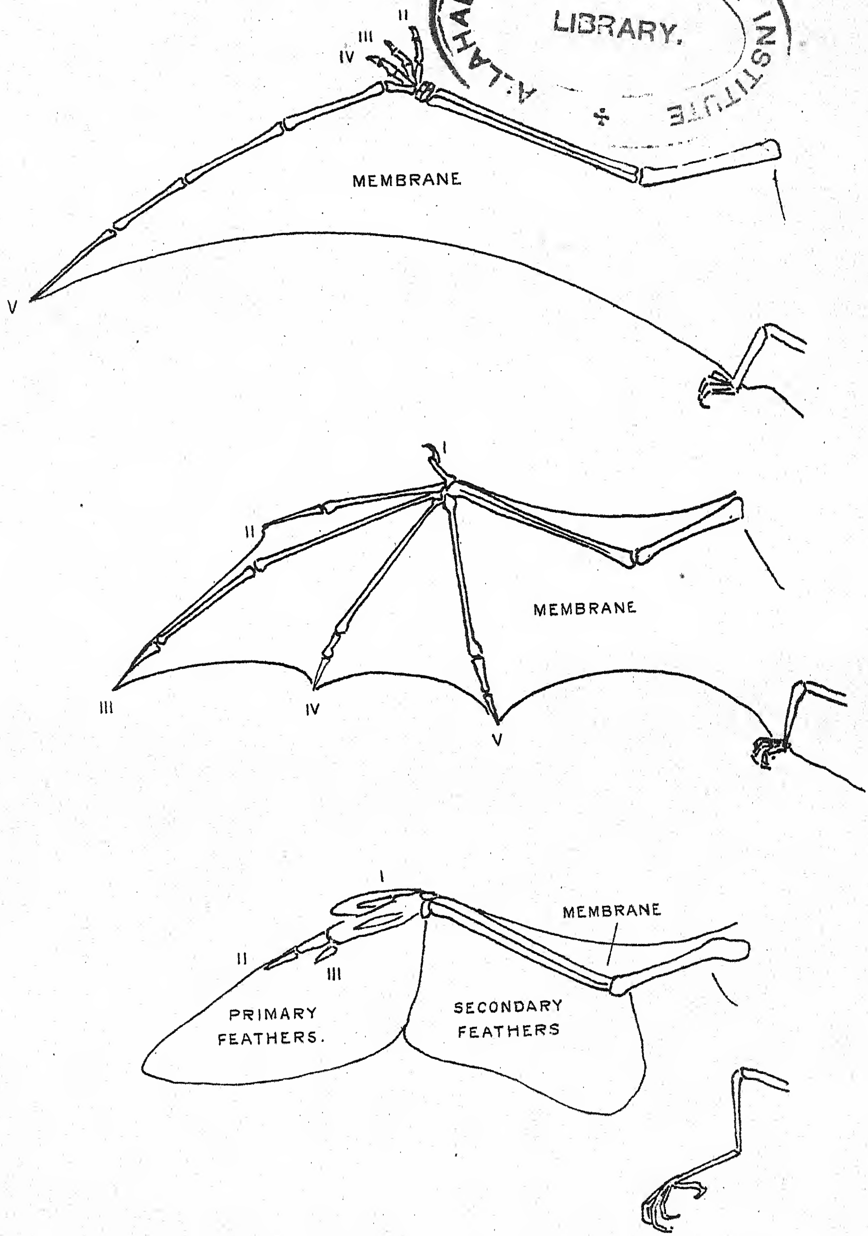
however, was enormously enlarged and served as the support for the membranes of the wings. Extending its arms and its little fingers, the pterodactyle held its membranes in position for flight, but we may well believe that it was capable of little beyond a clumsy flapping, a great advance indeed on the principle of the parachute but still far behind the perfect flight of a bird. Climbing about its movements must have been clumsy and slow, hampered by the weight and unwieldiness of the membranes.

The bat attained a superior mobility by a better dispersal of the supports of its wing. In the bat all five digits are definitely retained. The first indeed is often small, but in some species it is fairly long and armed with a powerful claw. The other four are lengthened after the fashion of the fifth digit of the pterodactyle and like it support the membrane, recalling the ribs of an umbrella. The result is, however, to make the flying surface more rigid and at the same time more capable of modification to suit currents of air, and some of the bats are most accomplished fliers. But, though the bats have thus solved the problem of efficient flight, they still lie under the same disability as the pterodactyle. The membrane is heavy and clumsy and the forelimbs are so long in proportion to the rest of the structure that the animal loses all other mobility. A bat on the ground is virtually an animal disabled. A bat hanging in a crevice or from a bough is much the same. One has only to watch a colony of Flying-foxes hanging uneasily at rest in the sunshine on a tree, or squabbling over the fruits of a tree by night to decide that they have paid too heavily for the gift of flight. They can fly, but they have lost most other attributes and they are practically defenceless against all enemies. The other mammals have been wise to renounce the gift of flight on these terms.

In the bird's wing we meet an entirely new principle. The membranes are reduced to an almost irreducible minimum; the limb is stiffened and flattened and shortened; while the flying surface is provided by a new substance, that of feathers. The new arrangement has innumerable advantages over the old and we must examine it in detail.

As we have seen, the flying membrane of the pterodactyle and the mammal is very cumbersome because of its attachment to all the limbs; it requires to be attached to the limbs in order that it may be kept taut in flight by the extension of the limbs; in itself it is no more capable of movement than a piece of elastic is capable of independent movement. Attached to the limbs, it impedes all other movements except that of flight. Unattached to them, it would flap loose and offer no support in the air, at the mercy of every varying current.

The first requisite of any new departure in the form of the forelimb as an instrument of flight must be firmness. If the new flying surface is not to be kept taut by stays from the hind limb, as was the old, it must itself be sufficiently strong to withstand the enormous pressure from the air. The largest possible sail area on a ship would be valueless if it were allowed to flap loosely in the wind, and the sail of a ship is only required to move that ship along a horizontal plane; it has not the further function of supporting



COMPARISON OF THE WINGS OF PTERODACTYLE, BAT AND BIRD (after Pyecraft).

it in the vertical plane. To put the problem into terms of the sail—the flying membrane of the bat is like the sail held taut between two yards and the mast. If it were required to provide a sail area without these three supports to keep it taut, the material of the sail must change to a firmer one and the single support chosen must be greatly strengthened and modified for firmness.

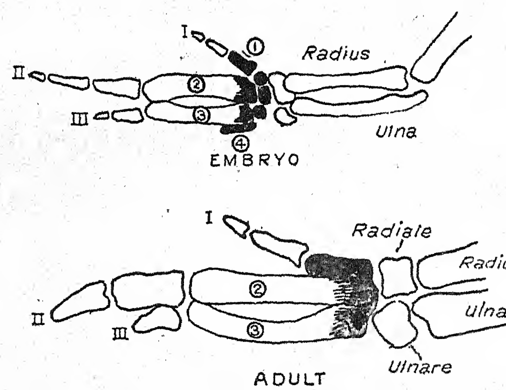
This is what has happened in the bird. The forelimb has been modified both for strength and for rigidity. The membrane has given place to a new material infinitely superior in strength, in lightness and in adaptability to the most varied strains; and the new modifications have at the same time proved infinitely more convenient. They do not affect mobility other than by flight. But by the inexorable laws of the universe these great advantages have had their price. The forelimb has become a marvellous wing, but it has lost its use for other purposes. The changes must be described in some detail.

First, to deal with the actual modifications of the limb. Glancing again at one's own arm and comparing it with that of the ordinary mammal, one realizes that the human forelimb has been modified in the direction of suppleness and mobility. Taking my hand from the paper, I notice I can move it about in every plane with an infinite variety of contortion and ease. I cannot fly; but, on the other hand, I am capable of a thousand actions denied to the forelimb of the bird or the mammal: The bird's wing, on the other hand, can move in all planes with relation to its body, but in itself it is capable of movement only in one plane. The upper arm, the forearm and the hand move only in one plane with each other, as the blade of a pocket knife in relation to the sheath, to use Professor Thompson's illustration. In that one plane it is capable of a variety of positions, running the whole gamut between the closed wing tucked in under the shelter of the scapulars and the wing at its widest expanse. There is one interesting point: the bones cannot be quite completely extended when the wing is open. For, in the remains of the patagium running along the front of the wing from the upper arm to the lower arm, there is an elastic band (*tensor patagii longus* by name) which prevents their complete extension. The reason for this would seem to be that, if in flight the wing were completely extended with the greatest pressure of the air along this fore-edge, there would be danger of the wing cockling up, being 'blown inside-out' like an umbrella.

This immobility of the wing except on one plane of course greatly increases its strength in movement. No effort has to be wasted in flight on keeping the wing itself firm as a basis for the feathers. Imagine a man rowing in a boat: if his feet are braced against a solid bar of wood, his strength is all exerted towards the movement of the boat. If he has nothing to brace his feet against or only a yielding substance like a net or rope, much of his muscular effort is expended in other directions than the movement of the boat. The value of this firmness in the bird's wing is emphasized by the changes which have taken place in the hand and wrist. These support the primary feathers, the longest and most important feathers of flight. And firmness and lack of subsidiary movement

are so important here that the mobile wrist and hand have become fused into a solid unmoving block. This is how it has come about.

We saw above that the typical wrist and hand contain three distinct series of bones, first the carpals or wrist proper, the metacarpals or palm, and finally the phalanges or digits. The mobility of the human wrist is attained by the presence of eight separate carpal bones with the varied play that they give. As play is not required in the bird's wrist, these bones have gradually disappeared. If the wing of an adult fowl is dissected, only two carpal bones will be found, known respectively as the *radiale* and the *ulnare* from their position with regard to the radius and the ulna bones. But in the embryo fowl there are still in addition three other carpal bones between the radiale and the ulnare and the metacarpals. These disappear by fusion with the ends of the first three metacarpals and with them vanish part of the mobility of the wrist. This, however, is not enough. The hand itself must become a solid shaft, and this is attained by the fusion of the metacarpals or palm and the disappearance of some of the digits. It is as if the hand withered and shrank and grew solid, needed not as a hand but as a firm support.



Hand and wrist of Domestic Fowl, to show the origin of the carpo-metacarpal bone.

Figures in circles show the metacarpals. Black areas show the separate bones and their point of fusion.

The result is the carpo-metacarpal bone, which is peculiar to birds. This is best understood by reference to the figures above. Its base is composed of the three lost carpal bones and a vestige of the third metacarpal; its main shaft is the second metacarpal swollen and flattened, while the arch of bone that springs from it to support the primaries is the third metacarpal. To the base of the last is fused the final vestige of the fourth metacarpal. The fifth has irretrievably vanished. The scanty remains of the digits will be seen in the figure. They have already been referred to in the first article of this series (Vol. XXXIII, 173).

This firmly built wing must have evolved gradually at the same time as the feathers, without which it would have been useless for flight. We have already seen (Vol. XXXIII, 170) how the feather

is believed to be a legacy from the reptilian scale. Its structure was described on p. 313. No better instrument for its purpose could be imagined.

We saw that the structure of a feather combined the three attributes of strength, of elasticity and of lightness, all so important for its purpose. Considering the flight feathers alone, the primaries and secondaries and the feathers of the tail, we find that the shaft is a strong quadrilateral tube packed with a fine pith serving as a strut to support a given portion of the sail area, that is the web with the toughness and the play of its innumerable barbs, barbules and barbicels. At rest, when the wing is folded, each feather fits away beneath the next like the blades of a fan, occupying the minimum of space and in no way hindering the other movements of the bird. Extended in flight, the feathers all overlap in just the right proportions, with one narrow and one broad vane, to attain the maximum effect with a minimum expenditure. On the down stroke each feather is held firm by the overlap of the feather behind it; on the up stroke the vane gives and allows the air to pass through, minimising a resistance which would otherwise force the bird down and lose the value of the previous down stroke. Each feather is a separate entity and is easily replaced in case of damage without affecting the power of flight; while moulted one by one on each wing in pairs, the whole are capable of renewal when wear has impaired their usefulness without the bird being deprived for a moment of the most essential attribute of its life. The space between the base of the larger feathers is carefully packed by the series of coverts, above and below, each functioning according to the direction of the stroke.

Apart from the subtle play of the individual feathers, the bird's flight also gains from the curvatures of the wing itself. The rounded curves vary considerably in different species of birds and in different areas of any particular wing. The convex upper surface allows the air to glide off easily during the up stroke, acting with the individual arrangement of the feathers to minimise resistance. The concave lower surface increases the sustaining power of the wing, whilst the firmness of the forelimb itself in front, compared with the resilience of the feather tips behind, forces the pressure of air out backwards and so drives the bird forward with each stroke.

There are three small points of great interest which may well be cited as examples of the perfection of the adaptation of every part of the wing to its work. In systematic books under the descriptions of birds and especially under the keys to their identification, we often find it stated that the primaries are notched or emarginated, with often differences in these respects between closely allied species. A glance at the key to the Harriers (*Circus*) will at once supply an example. There is no doubt that these variations in the edges of these important feathers have two purposes. They serve to lock the primaries together in flight, strengthening the bases and where necessary allowing the ends of the primaries to splay out in flight like the fingers of a hand. In vultures and eagles, for instance, the widely spread feathers

at the end of the wing curved upwards by the pressure of the air are a most characteristic feature of the silhouette in flight. It is believed that this device allows the air waves caused by the down stroke to pass gradually outwards without producing a disadvantageous vortex.

The third point is the presence in some species of a very mobile bastard-wing, as the feathers on the first digit are often called. This appears to have some braking or balancing quantities useful at the moment when the flying bird alights.

The infinite variations of which the structure of the bones of the wing and of the various feathers are capable would themselves alone contain material for a book. The developments correspond of course with the powers of flight of the individual species.

As a general rule, it may be stated that birds of weak flight have a short, rounded wing, whilst a long, pointed wing is the mark of a fast or skilful flier. The familiar Jungle Babbler (*Turdoides terricolor*) at once occurs to one as an example of the former, whilst the common Indian Swift (*Micropus affinis*) supplies a type of the latter. The reason for this is apparently that the secondary and primary feathers have each a different function to perform. The secondaries are of major importance in the stroke; they actually grip the air and support the bird. But all finesse of speed and steering is imparted by the primaries. In the short, rounded wing the primaries serve as little but an extension of the secondaries. The babbler therefore can fly efficiently as far as his needs and his strength allow, but he is quite incapable of speed above the average or of sudden turns and movements in every plane. Other factors of course enter into the character of flight. The ratio of the wing area to the total weight of the bird, the ratio of the length to the breadth of the wing, the strength of the pectoral muscles and the pace at which they are capable of moving the wings are all of primary importance, whilst in highly specialized fliers the whole body may be altered to reduce the resistance of air-pressure.

The big swifts of the genera *Micropus* and *Hirundinapus* are commonly accepted as the most highly specialised for flight of all birds. Their pace in the air easily exceeds that of all other birds, whilst their flying hours practically coincide with the hours of daylight. A superficial examination of their characteristics will give us some idea of what is required by a bird for perfection in flight, perfection for the moment being regarded solely in terms of speed and ease of steering.

Compared with the weight, the sail area in the Swift is reduced to a minimum; the wings are long, thin and extremely pointed; their line is that of a backward curve. The firmness of the forelimb is such that it is almost rigid, and this attribute is increased by the shortness of the humerus so that the Swift's forelimb is almost as exaggerated and specialised a limb in its own way as that of the Mole. The secondaries and inner primaries are very short, the outer primaries are very long and both series are composed of hard narrow feathers which exaggerate the salient features of the wing.

The wings themselves are thus perfect for speed and steering. Their effect is heightened by the attributes of the bird itself. The

head and body combine the characteristics of a 'torpedo-body' as the designer of a fast motor-craft would designate it. The head is set close into the body with a short stiff neck and the hard short feathers with their oily polish complete the stream-line. The wings are set forward and high on this torpedo-body, so that the centre of gravity is far below the centre of suspension. This is emphasised by the manner in which the body is ballasted. The lungs and air-sacs are in the upper part of the thorax, the pectoral muscles and the heavy vessels of the abdominal cavity with the heart and liver below. The tail is short and stiff, setting off the lines of the body and it is forked, that is, the unnecessary centre is cut away, leaving the sides for their work of adjustment of balance. The legs are tiny, partly because they are suffering from atrophy, nature's penalty for disuse in a bird that lives on the wing, and partly that they may be tucked neatly away in the line of the feathers and afford no resistance to the air.

Finally, that acute observer, Mr. B. B. Osmaston, has pointed out that the Swifts have apparently attained to the power of alternate strokes with the wings. In ordinary flight all birds flap their wings in unison, up stroke and down stroke in concert, like a man swimming with the breast stroke. But sometimes, at any rate, the Swift strikes the air with alternate wings; it is the rotary engine with no loss of time or power between the strokes. Specialisation for flight can hardly go any further than in the Swift, but it has been gained by a loss of all the amenities and pleasures that we see in other birds' lives. Off the wing the Swift can do nothing at all except brood its eggs or nest in a crevice.

A great deal has been studied and written about the attributes and the mechanics of birds' flight. But I do not propose to summarize the conclusions that have been arrived at as it is obvious that the subject requires treatment anew by someone who is both an airman and an ornithologist. The immense practical knowledge obtained from the designing and flying of air-craft in the last twenty years must necessarily revolutionise the theories advanced by the students of birds' flight. It will suffice to say here that the flight of birds falls naturally into three main types.

The first is that of ordinary flight, very variable as may be its forms. This combines the principle of the parachute and the oar. If the bird starts from an elevated perch, it leaps off headlong trusting to the wings as parachutes, like the primeval membrane, it starts as it would from the ground by raising the wings vertically above the back. The speed and completeness of this movement is readily understood from a pigeon whose wings strike together above the back with a loud clap when the bird is suddenly startled. Then the wings move forward and downwards, backwards under the plane of the body and then upwards again. The upward stroke is very fast and thanks to the curves of the wing's surface and the set of its feather it meets with far less air-resistance and so does not cause the bird to lose much way. The complete movement of the wing in ordinary flight is complex; the line described by the tip of the wing for each stroke forms a sort of figure-of-eight, the lower loop of the eight being much smaller than the upper.

The simplest form of this flight may be seen any day amongst the various babblers. They flap their wings with these figure of eight strokes several times and then glide along, wings held rigidly outstretched, with the resulting momentum, until its finish compels them to work the wings again. Soaring and hovering are the other two types of flight and they are not so easily understood. The first may be seen any day in India. It is particularly characteristic of the vultures and storks which may be seen circling high in the sky, often at such a distance from the ground that the birds appear as faint specks.

It is giddy work watching the vultures soaring. One stares up into the bright unending dome of the Indian sky across which several vultures are wheeling in huge unending circles; the eye grows familiar with the light and distance, and then other vultures strike the consciousness, wheeling their unceasing patrol, minuter specks still higher in the dome until they melt out of sight. Round and round wind the circles, untiring, endless, to all seeming purposeless, though, as we know, the birds are watching for their food. There are no visible strokes of the wings. The huge birds simply float round without apparent volition, slightly banking as they turn. Now and again one changes its course and proceeds in the opposite direction. Occasionally the wings flap and the bird travels a short distance as if tired of its soaring; but speaking loosely, the birds can soar for an hour and more at a time without a stroke of the wings and with no apparent loss of speed or altitude. Many and conflicting theories have been advanced as to how the birds maintain their speed and altitude in this manner, but the air-men must study it all afresh.

Hovering is the reverse of soaring; the bird expends a maximum of effort to retain a stationary position in the air. Two very familiar examples will at once occur to the Indian ornithologist—the Kestrel (*Cerchneis tinnunculus*) hovering high over the land, and the Pied Kingfisher (*Ceryle rudis*) hovering over the water. In both cases the birds have the power of hanging absolutely stationary in the air to watch for their prey beneath. The effort involved must be very great, the wings beating at high pressure. The Humming Birds of America are the greatest exponents of this type of flying. They hang suspended before a flower while they probe it for food and their wings beat at such high speed that they are almost invisible. Many birds can hover just for a moment for a particular purpose. For instance, one sees many of the little warblers of the genus *Phylloscopus* dart up to capture an insect from the underside of a leaf, hovering just for a moment whilst they pick it off; and in this group the delicate little Pallas's Willow-Warbler (*Phylloscopus proregulus*) feeds so regularly in this way that one can identify it in the Himalayas by the habit which reveals its canary yellow rump to perfection. But very few species can hover thus for any length of time. Besides the Kestrel and the Kingfisher, only the Short-toed Eagle (*Circaëtus gallicus*) and the Black-winged Kite (*Elanus cœruleus*) occur to me in India as equal exponents of the art.

A point which always excites great interest is the speed at which

various species of birds can fly. Very little attention appears to have been paid to this subject in India, but various authors have studied it in other countries. The natural tendency is probably always to over-estimate the speed of birds. Gatke the veteran ornithologist of Heligoland, for instance, as a result of his studies of migration, estimated that Hooded Crows fly at 108 miles per hour and Bluethroats at 180 miles per hour while on passage. Some of the waders he was prepared to credit with a pace of 4 miles a minute! There is also an oft-quoted case of a Swallow sent from Roubaix to Paris—160 miles—which covered the distance at a speed of over 100 miles an hour. Gatke's estimates were certainly wrong. In the *Ibis* for 1921, Colonel Meinertzhagen has given the result of a careful collection of available trustworthy records, original and otherwise. He arrived at the result that birds have two speeds—a normal rate which is used for everyday purposes and also migration, and an accelerated speed which is used for protection or pursuit or courtship and which in some cases nearly doubles the rate of their normal speed. He finally lays down a table of normal average speeds as follows in miles per hour:—

Corvidæ 31-45	Starlings 38-49	Sandgrouse 43-47
Smaller Passeres 20-37	Falcons 40-48	Waders 40-51
Geese 42-45	Ducks 44-59	

He considers also that the normal speed of a Carrier-Pigeon is from 30-36 miles per hour, but that, when 'homing', they can attain a speed of 60 miles per hour and over.

To this gift of speed and the gradually developed ability to maintain it for long distances is due the fact that birds are able to migrate. The possibility of migration with the consequence that they can vary their residence in accordance with the food supply has led to the wide dispersal of species, the multiplication of forms and the abundance of individuals. It is comparable to the sudden revolution in the habits of man which has come in the course of twenty years through the invention of the internal combustion engine, which has annihilated time and space.

Before leaving the subject of the wing, it is necessary to touch on two other aspects of it, though they are not of equal importance. The first is the use of the wing as a paddle in water. The second is its use as an organ of offence.

There are of course many birds which fly and are equally at home in the water, with or without special adaptations to it. The very simplest case is probably that of the Dipper (*Cinclus*) of which several forms are common along the Himalayas. To look at, the Dipper is a perfectly ordinary Passerine bird, rather stout and stumpy in appearance. Its only noticeable features are its very dense plumage and its feathered eyelids. Without previous acquaintance with the fact, I doubt whether one would guess that the Dipper was an aquatic bird on first handling a specimen. Yet the Dipper is equally at home on the wing, on the banks and stones of a mountain stream, swimming on the water, or feeding beneath its surface. The Dipper walks about on the bed of the stream as if

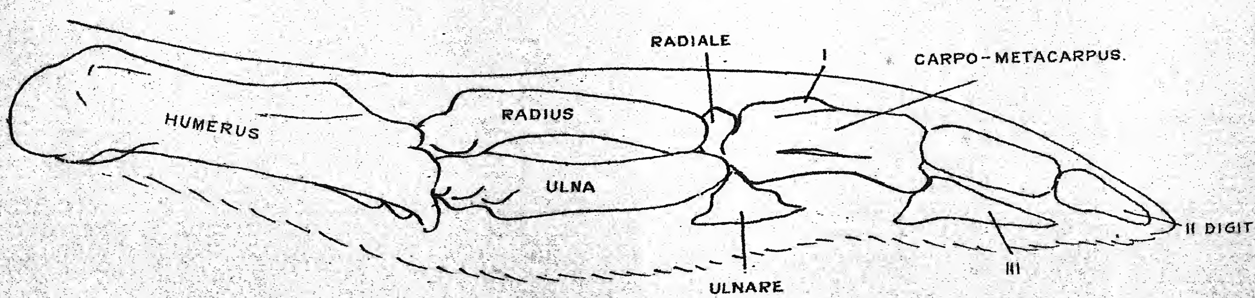
on dry land. It can swim and dive using its perfectly normal wings as paddles, wings which support it as easily in the air. The wings are short and rounded but no more so than those of innumerable other species of Passerine birds.

Now the use of the wing as a paddle is not essential to a bird for swimming and diving under water. The Grebe and the Cormorant and the Darter, for instance, are all birds of strong flight which are at the same time absolutely at home under water but owe their powers under water simply to the use of their feet for propulsion. The Little Auk and the Puffin use both their wings and legs under water, without in the case of the latter having in any way lost the power of flight, though the former is not very strong on the wing. Its extinct relative, the famous Great Auk, whose eggs fetch such great prices in the auction-room, swam with its legs and used its wings under water for diving. The great Auk had so neglected the proper use of its wings that it had become flightless and the wings were relatively small by atrophy, though they still retained the normal aspect of wings.

In the Penguins (*Sphenescidæ*) the wing has, however, become a definite paddle resembling the flippers of a cetacean or turtle and scarcely recalling a wing at all. They are clothed with feathers that in appearance have almost become scales again and which at the moult flake off in patches. There are no flight quills and the whole limb is incapable of flexure except at the shoulder joint. They cannot be folded up or held except in the stiff flipper-like manner to which we are all accustomed from pictures. No pollex or first digit is present. Yet a slight examination shows that this specialised paddle is merely a modified wing (Plate C). Its skeleton reveals all the essential features of a wing, albeit it is with a great flattening and broadening of the bones and an enlargement of the carpals; and Pycraft has shown that in the embryo the bones agree still more closely with those of a normal wing, including the presence still of the first digit. In accordance with this great transformation, the Penguin differs from all other birds in its mode of swimming and diving. The paddles work with a rotary motion after the manner of the wing in flight, and the feet, instead of contributing to the progress, are stretched out stiffly backwards as in a flying bird. Yet from the bones of the pelvic girdle and the webbing of the feet Pycraft deduces that the Penguin originally swam with its feet and used its wings merely to help its progress, after the manner of the Auks.

The use of the wing as a weapon of offence is far less important. Its use thus is probably best known amongst the Pigeons and Doves which strike at each other with their wings when fighting in a desultory and ineffective way. Some birds like the Jacanas (*Parridæ*), the Spur-winged Plovers (*Hoplopterus*) and the Red-wattled Lapwing (*Lobivanellus indicus*) possess a horny spur on the carpal joint, and it is commonly stated that they use the spur as an offensive weapon, though I have never seen any proof of the fact.

Any discussion of wings and flight seems incomplete without some mention of the tail, though I cannot help feeling that the tail is not so completely an appanage of flight as we are accustomed



THE PADDLE OF A PENGUIN
to show the bones of the hand and wrist
(after Pyecraft).

to think it. We have got to remember its origin. We have already seen (Vol. XXXIII, p. 172) that in *Archæopteryx* the tail was quite distinct in appearance from that of the modern bird. It was a long tapering organ of about twenty-one vertebrae and from each of the last 13 or 16 vertebrae sprang a pair of well developed feathers, one on each side of the bone. This tail at once suggests to us the tail of a reptile with the addition of feathers, which of course it is. It also explains the construction of a modern bird's tail. This consists of five to eight free vertebrae, followed by the fusion of six to ten others into a bony plate known as the *Pygostyle,* which supports the fan of tail feathers. To put it briefly, some of the vertebrae have been lost and the others have telescoped together, the opposing pairs of feathers being thereby drawn into a fan.

The reason for the change seems obvious. To a reptile a long heavy tail must be a valuable fulcrum inducing to quickness of movement. To a reptile inclining to an upright position and to the arboreal life with tendencies to a parachuting flight, a long heavy tail must still be of value both as a fulcrum and as an aid to balance. But to the bird of perfect flight, gained by the adjusting of balance and gravity to the use of light feather wings a long vertebral tail could only be a hindrance; muscular power and energy would be expended in keeping it horizontal in flight; its weight so far behind would upset the other needs of gravity and flight. And if its feathers could take its place they would serve just as well for all the purposes of balance and steering. And this is what has happened.

The feather tail of a bird is an extremely variable and mobile organ; we find it in all sorts of shapes and sizes, long and short, broad and narrow, heavy and light. The feathers are modified for special uses as in the woodpeckers and tree-creepers where it supports the birds against the tree trunks they climb; they are adorned and modified for sexual displays both by colour and form; where they are not required as in the Grebe and the Bustard-Quail, they are cut down to an absolute minimum. But in all guises and forms the tail remains not an instrument of flight, for it is just as important to the walking or perching bird, but an instrument of balance. The tail is used in flight of course—one has only to watch the Pariah Kite (*M. m. govinda*) soaring above the bazaar to see that the feathers are in a constant state of movement. But it is not a necessary concomitant of flight. Pull out the tail feathers and the bird will not be disabled from flight. It is the balancing pole serving to emphasize the steering done by the primaries and head. With the tail the bird can perform its aerial evolutions more cleanly; without the tail it can still perform them.

(To be continued)

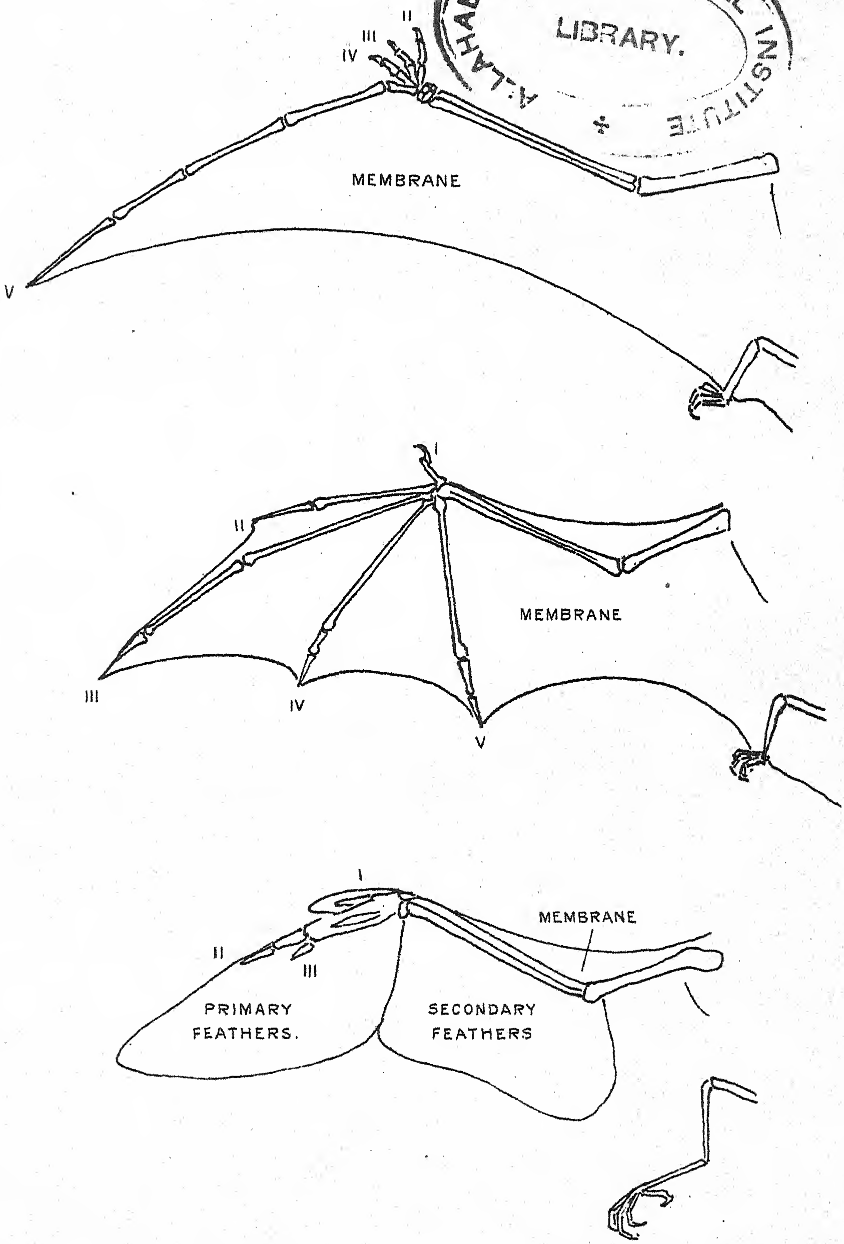
however, was enormously enlarged and served as the support for the membranes of the wings. Extending its arms and its little fingers, the pterodactyle held its membranes in position for flight, but we may well believe that it was capable of little beyond a clumsy flapping, a great advance indeed on the principle of the parachute but still far behind the perfect flight of a bird. Climbing about its movements must have been clumsy and slow, hampered by the weight and unwieldiness of the membranes.

The bat attained a superior mobility by a better dispersal of the supports of its wing. In the bat all five digits are definitely retained. The first indeed is often small, but in some species it is fairly long and armed with a powerful claw. The other four are lengthened after the fashion of the fifth digit of the pterodactyle and like it support the membrane, recalling the ribs of an umbrella. The result is, however, to make the flying surface more rigid and at the same time more capable of modification to suit currents of air, and some of the bats are most accomplished fliers. But, though the bats have thus solved the problem of efficient flight, they still lie under the same disability as the pterodactyle. The membrane is heavy and clumsy and the forelimbs are so long in proportion to the rest of the structure that the animal loses all other mobility. A bat on the ground is virtually an animal disabled. A bat hanging in a crevice or from a bough is much the same. One has only to watch a colony of Flying-foxes hanging uneasily at rest in the sunshine on a tree, or squabbling over the fruits of a tree by night to decide that they have paid too heavily for the gift of flight. They can fly, but they have lost most other attributes and they are practically defenceless against all enemies. The other mammals have been wise to renounce the gift of flight on these terms.

In the bird's wing we meet an entirely new principle. The membranes are reduced to an almost irreducible minimum; the limb is stiffened and flattened and shortened; while the flying surface is provided by a new substance, that of feathers. The new arrangement has innumerable advantages over the old and we must examine it in detail.

As we have seen, the flying membrane of the pterodactyle and the mammal is very cumbersome because of its attachment to all the limbs; it requires to be attached to the limbs in order that it may be kept taut in flight by the extension of the limbs; in itself it is no more capable of movement than a piece of elastic is capable of independent movement. Attached to the limbs, it impedes all other movements except that of flight. Unattached to them, it would flap loose and offer no support in the air, at the mercy of every varying current.

The first requisite of any new departure in the form of the forelimb as an instrument of flight must be firmness. If the new flying surface is not to be kept taut by stays from the hind limb, as was the old, it must itself be sufficiently strong to withstand the enormous pressure from the air. The largest possible sail area on a ship would be valueless if it were allowed to flap loosely in the wind, and the sail of a ship is only required to move that ship along a horizontal plane; it has not the further function of supporting



COMPARISON OF THE WINGS OF PTERODACTYLE, BAT AND BIRD
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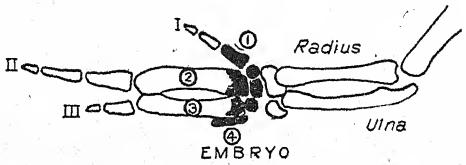
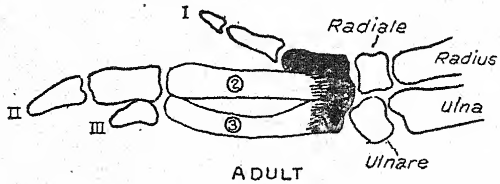
This immobility of the wing except on one plane of course greatly increases its strength in movement. No effort has to be wasted in flight on keeping the wing itself firm as a basis for the feathers. Imagine a man rowing in a boat: if his feet are braced against a solid bar of wood, his strength is all exerted towards the movement of the boat. If he has nothing to brace his feet against or only a yielding substance like a net or rope, much of his muscular effort is expended in other directions than the movement of the boat. The value of this firmness in the bird's wing is emphasized by the changes which have taken place in the hand and wrist. These support the primary feathers, the longest and most important feathers of flight. And firmness and lack of subsidiary movement

are so important here that the mobile wrist and hand have become fused into a solid unmoving block. This is how it has come about.

We saw above that the typical wrist and hand contain three distinct series of bones, first the carpals or wrist proper, the metacarpals or palm, and finally the phalanges or digits. The mobility of the human wrist is attained by the presence of eight separate carpal bones with the varied play that they give. As play is not required in the bird's wrist, these bones have gradually disappeared. If the wing of an adult fowl is dissected, only two carpal bones will be found, known respectively as the *radiale* and the *ulnare* from their position with regard to the radius and the ulna bones. But in the embryo fowl there are still in addition three other carpal bones between the radiale and the ulnare and the metacarpals. These disappear by fusion with the ends of the first three metacarpals and with them vanish part of the mobility of the wrist. This, however, is not enough. The hand itself must become a solid shaft, and this is attained by the fusion of the metacarpals or palm and the disappearance of some of the digits. It is as if the hand withered and shrank and grew solid, needed not as a hand but as a firm support.





Hand and wrist of Domestic Fowl, to show the origin of the carpo-metacarpal bone.

Figures in circles show the metacarpals. Black areas show the separate bones and their point of fusion.

The result is the carpo-metacarpal bone, which is peculiar to birds. This is best understood by reference to the figures above. Its base is composed of the three lost carpal bones and a vestige of the third metacarpal; its main shaft is the second metacarpal swollen and flattened, while the arch of bone that springs from it to support the primaries is the third metacarpal. To the base of the last is fused the final vestige of the fourth metacarpal. The fifth has irretrievably vanished. The scanty remains of the digits will be seen in the figure. They have already been referred to in the first article of this series (Vol. XXXIII, 173).

This firmly built wing must have evolved gradually at the same time as the feathers, without which it would have been useless for flight. We have already seen (Vol. XXXIII, 170) how the feather

is believed to be a legacy from the reptilian scale. Its structure was described on p. 313. No better instrument for its purpose could be imagined.

We saw that the structure of a feather combined the three attributes of strength, of elasticity and of lightness, all so important for its purpose. Considering the flight feathers alone, the primaries and secondaries and the feathers of the tail, we find that the shaft is a strong quadrilateral tube packed with a fine pith serving as a strut to support a given portion of the sail area, that is the web with the toughness and the play of its innumerable barbs, barbules and barbicels. At rest, when the wing is folded, each feather fits away beneath the next like the blades of a fan, occupying the minimum of space and in no way hindering the other movements of the bird. Extended in flight, the feathers all overlap in just the right proportions, with one narrow and one broad vane, to attain the maximum effect with a minimum expenditure. On the down stroke each feather is held firm by the overlap of the feather behind it; on the up stroke the vane gives and allows the air to pass through, minimising a resistance which would otherwise force the bird down and lose the value of the previous down stroke. Each feather is a separate entity and is easily replaced in case of damage without affecting the power of flight; while moulted one by one on each wing in pairs, the whole are capable of renewal when wear has impaired their usefulness without the bird being deprived for a moment of the most essential attribute of its life. The space between the base of the larger feathers is carefully packed by the series of coverts, above and below, each functioning according to the direction of the stroke.

Apart from the subtle play of the individual feathers, the bird's flight also gains from the curvatures of the wing itself. The rounded curves vary considerably in different species of birds and in different areas of any particular wing. The convex upper surface allows the air to glide off easily during the up stroke, acting with the individual arrangement of the feathers to minimise resistance. The concave lower surface increases the sustaining power of the wing, whilst the firmness of the forelimb itself in front, compared with the resilience of the feather tips behind, forces the pressure of air out backwards and so drives the bird forward with each stroke.

There are three small points of great interest which may well be cited as examples of the perfection of the adaptation of every part of the wing to its work. In systematic books under the descriptions of birds and especially under the keys to their identification, we often find it stated that the primaries are notched or emarginated, with often differences in these respects between closely allied species. A glance at the key to the Harriers (*Circus*) will at once supply an example. There is no doubt that these variations in the edges of these important feathers have two purposes. They serve to lock the primaries together in flight, strengthening the bases and where necessary allowing the ends of the primaries to splay out in flight like the fingers of a hand. In vultures and eagles, for instance, the widely spread feathers

at the end of the wing curved upwards by the pressure of the air are a most characteristic feature of the silhouette in flight. It is believed that this device allows the air waves caused by the down stroke to pass gradually outwards without producing a disadvantageous vortex.

The third point is the presence in some species of a very mobile bastard-wing, as the feathers on the first digit are often called. This appears to have some braking or balancing quantities useful at the moment when the flying bird alights.

The infinite variations of which the structure of the bones of the wing and of the various feathers are capable would themselves alone contain material for a book. The developments correspond of course with the powers of flight of the individual species.

As a general rule, it may be stated that birds of weak flight have a short, rounded wing, whilst a long, pointed wing is the mark of a fast or skilful flier. The familiar Jungle Babbler (*Turdoides terricolor*) at once occurs to one as an example of the former, whilst the common Indian Swift (*Micropus affinis*) supplies a type of the latter. The reason for this is apparently that the secondary and primary feathers have each a different function to perform. The secondaries are of major importance in the stroke; they actually grip the air and support the bird. But all finesse of speed and steering is imparted by the primaries. In the short, rounded wing the primaries serve as little but an extension of the secondaries. The babbler therefore can fly efficiently as far as his needs and his strength allow, but he is quite incapable of speed above the average or of sudden turns and movements in every plane. Other factors of course enter into the character of flight. The ratio of the wing area to the total weight of the bird, the ratio of the length to the breadth of the wing, the strength of the pectoral muscles and the pace at which they are capable of moving the wings are all of primary importance, whilst in highly specialized fliers the whole body may be altered to reduce the resistance of air-pressure.

The big swifts of the genera *Micropus* and *Hirundinapus* are commonly accepted as the most highly specialised for flight of all birds. Their pace in the air easily exceeds that of all other birds, whilst their flying hours practically coincide with the hours of daylight. A superficial examination of their characteristics will give us some idea of what is required by a bird for perfection in flight, perfection for the moment being regarded solely in terms of speed and ease of steering.

Compared with the weight, the sail area in the Swift is reduced to a minimum; the wings are long, thin and extremely pointed; their line is that of a backward curve. The firmness of the forelimb is such that it is almost rigid, and this attribute is increased by the shortness of the humerus so that the Swift's forelimb is almost as exaggerated and specialised a limb in its own way as that of the Mole. The secondaries and inner primaries are very short, the outer primaries are very long and both series are composed of hard narrow feathers which exaggerate the salient features of the wing.

The wings themselves are thus perfect for speed and steering. Their effect is heightened by the attributes of the bird itself. The

head and body combine the characteristics of a 'torpedo-body' as the designer of a fast motor-craft would designate it. The head is set close into the body with a short stiff neck and the hard short feathers with their oily polish complete the stream-line. The wings are set forward and high on this torpedo-body, so that the centre of gravity is far below the centre of suspension. This is emphasised by the manner in which the body is ballasted. The lungs and air-sacs are in the upper part of the thorax, the pectoral muscles and the heavy vessels of the abdominal cavity with the heart and liver below. The tail is short and stiff, setting off the lines of the body and it is forked, that is, the unnecessary centre is cut away, leaving the sides for their work of adjustment of balance. The legs are tiny, partly because they are suffering from atrophy, nature's penalty for disuse in a bird that lives on the wing, and partly that they may be tucked neatly away in the line of the feathers and afford no resistance to the air.

Finally, that acute observer, Mr. B. B. Osmaston, has pointed out that the Swifts have apparently attained to the power of alternate strokes with the wings. In ordinary flight all birds flap their wings in unison, up stroke and down stroke in concert, like a man swimming with the breast stroke. But sometimes, at any rate, the Swift strikes the air with alternate wings; it is the rotary engine with no loss of time or power between the strokes. Specialisation for flight can hardly go any further than in the Swift, but it has been gained by a loss of all the amenities and pleasures that we see in other birds' lives. Off the wing the Swift can do nothing at all except brood its eggs or nest in a crevice.

A great deal has been studied and written about the attributes and the mechanics of birds' flight. But I do not propose to summarize the conclusions that have been arrived at as it is obvious that the subject requires treatment anew by someone who is both an airman and an ornithologist. The immense practical knowledge obtained from the designing and flying of air-craft in the last twenty years must necessarily revolutionise the theories advanced by the students of birds' flight. It will suffice to say here that the flight of birds falls naturally into three main types.

The first is that of ordinary flight, very variable as may be its forms. This combines the principle of the parachute and the oar. If the bird starts from an elevated perch, it leaps off headlong trusting to the wings as parachutes, like the primeval membrane, it starts as it would from the ground by raising the wings vertically above the back. The speed and completeness of this movement is readily understood from a pigeon whose wings strike together above the back with a loud clap when the bird is suddenly startled. Then the wings move forward and downwards, backwards under the plane of the body and then upwards again. The upward stroke is very fast and thanks to the curves of the wing's surface and the set of its feather it meets with far less air-resistance and so does not cause the bird to lose much way. The complete movement of the wing in ordinary flight is complex; the line described by the tip of the wing for each stroke forms a sort of figure-of-eight, the lower loop of the eight being much smaller than the upper.

The simplest form of this flight may be seen any day amongst the various babblers. They flap their wings with these figure of eight strokes several times and then glide along, wings held rigidly outstretched, with the resulting momentum, until its finish compels them to work the wings again. Soaring and hovering are the other two types of flight and they are not so easily understood. The first may be seen any day in India. It is particularly characteristic of the vultures and storks which may be seen circling high in the sky, often at such a distance from the ground that the birds appear as faint specks.

It is giddy work watching the vultures soaring. One stares up into the bright unending dome of the Indian sky across which several vultures are wheeling in huge unending circles; the eye grows familiar with the light and distance, and then other vultures strike the consciousness, wheeling their unceasing patrol, minuter specks still higher in the dome until they melt out of sight. Round and round wind the circles, untiring, endless, to all seeming purposeless, though, as we know, the birds are watching for their food. There are no visible strokes of the wings. The huge birds simply float round without apparent volition, slightly banking as they turn. Now and again one changes its course and proceeds in the opposite direction. Occasionally the wings flap and the bird travels a short distance as if tired of its soaring; but speaking loosely, the birds can soar for an hour and more at a time without a stroke of the wings and with no apparent loss of speed or altitude. Many and conflicting theories have been advanced as to how the birds maintain their speed and altitude in this manner, but the air-men must study it all afresh.

Hovering is the reverse of soaring; the bird expends a maximum of effort to retain a stationary position in the air. Two very familiar examples will at once occur to the Indian ornithologist—the Kestrel (*Cerchneis tinnunculus*) hovering high over the land, and the Pied Kingfisher (*Ceryle rudis*) hovering over the water. In both cases the birds have the power of hanging absolutely stationary in the air to watch for their prey beneath. The effort involved must be very great, the wings beating at high pressure. The Humming Birds of America are the greatest exponents of this type of flying. They hang suspended before a flower while they probe it for food and their wings beat at such high speed that they are almost invisible. Many birds can hover just for a moment for a particular purpose. For instance, one sees many of the little warblers of the genus *Phylloscopus* dart up to capture an insect from the underside of a leaf, hovering just for a moment whilst they pick it off; and in this group the delicate little Pallas's Willow-Warbler (*Phylloscopus proregulus*) feeds so regularly in this way that one can identify it in the Himalayas by the habit which reveals its canary yellow rump to perfection. But very few species can hover thus for any length of time. Besides the Kestrel and the Kingfisher, only the Short-toed Eagle (*Circaëtus gallicus*) and the Black-winged Kite (*Elanus cœruleus*) occur to me in India as equal exponents of the art.

A point which always excites great interest is the speed at which

various species of birds can fly. Very little attention appears to have been paid to this subject in India, but various authors have studied it in other countries. The natural tendency is probably always to over-estimate the speed of birds. Gatke the veteran ornithologist of Heligoland, for instance, as a result of his studies of migration, estimated that Hooded Crows fly at 108 miles per hour and Bluethroats at 180 miles per hour while on passage. Some of the waders he was prepared to credit with a pace of 4 miles a minute! There is also an oft-quoted case of a Swallow sent from Roubaix to Paris—160 miles—which covered the distance at a speed of over 100 miles an hour. Gatke's estimates were certainly wrong. In the *Ibis* for 1921, Colonel Meinertzhagen has given the result of a careful collection of available trustworthy records, original and otherwise. He arrived at the result that birds have two speeds—a normal rate which is used for everyday purposes and also migration, and an accelerated speed which is used for protection or pursuit or courtship and which in some cases nearly doubles the rate of their normal speed. He finally lays down a table of normal average speeds as follows in miles per hour:—

Corvidæ 31-45	Starlings 38-49	Sandgrouse 43-47
Smaller Passeres 20-37	Falcons 40-48	Waders 40-51
Geese 42-45	Ducks 44-59	

He considers also that the normal speed of a Carrier-Pigeon is from 30-36 miles per hour, but that, when 'homing', they can attain a speed of 60 miles per hour and over.

To this gift of speed and the gradually developed ability to maintain it for long distances is due the fact that birds are able to migrate. The possibility of migration with the consequence that they can vary their residence in accordance with the food supply has led to the wide dispersal of species, the multiplication of forms and the abundance of individuals. It is comparable to the sudden revolution in the habits of man which has come in the course of twenty years through the invention of the internal combustion engine, which has annihilated time and space.

Before leaving the subject of the wing, it is necessary to touch on two other aspects of it, though they are not of equal importance. The first is the use of the wing as a paddle in water. The second is its use as an organ of offence.

There are of course many birds which fly and are equally at home in the water, with or without special adaptations to it. The very simplest case is probably that of the Dipper (*Cinclus*) of which several forms are common along the Himalayas. To look at, the Dipper is a perfectly ordinary Passerine bird, rather stout and stumpy in appearance. Its only noticeable features are its very dense plumage and its feathered eyelids. Without previous acquaintance with the fact, I doubt whether one would guess that the Dipper was an aquatic bird on first handling a specimen. Yet the Dipper is equally at home on the wing, on the banks and stones of a mountain stream, swimming on the water, or feeding beneath its surface. The Dipper walks about on the bed of the stream as if

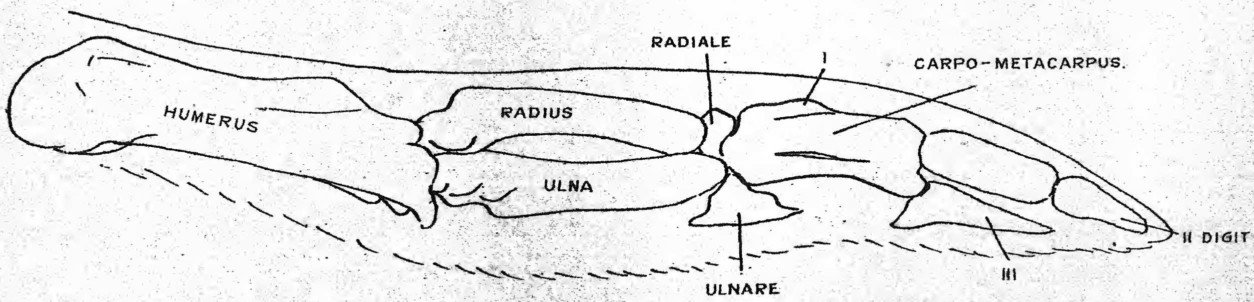
on dry land. It can swim and dive using its perfectly normal wings as paddles, wings which support it as easily in the air. The wings are short and rounded but no more so than those of innumerable other species of Passerine birds.

Now the use of the wing as a paddle is not essential to a bird for swimming and diving under water. The Grebe and the Cormorant and the Darter, for instance, are all birds of strong flight which are at the same time absolutely at home under water but owe their powers under water simply to the use of their feet for propulsion. The Little Auk and the Puffin use both their wings and legs under water, without in the case of the latter having in any way lost the power of flight, though the former is not very strong on the wing. Its extinct relative, the famous Great Auk, whose eggs fetch such great prices in the auction-room, swam with its legs and used its wings under water for diving. The great Auk had so neglected the proper use of its wings that it had become flightless and the wings were relatively small by atrophy, though they still retained the normal aspect of wings.

In the Penguins (*Sphenescidæ*) the wing has, however, become a definite paddle resembling the flippers of a cetacean or turtle and scarcely recalling a wing at all. They are clothed with feathers that in appearance have almost become scales again and which at the moult flake off in patches. There are no flight quills and the whole limb is incapable of flexure except at the shoulder joint. They cannot be folded up or held except in the stiff flipper-like manner to which we are all accustomed from pictures. No pollex or first digit is present. Yet a slight examination shows that this specialised paddle is merely a modified wing (Plate C). Its skeleton reveals all the essential features of a wing, albeit it is with a great flattening and broadening of the bones and an enlargement of the carpals; and Pycraft has shown that in the embryo the bones agree still more closely with those of a normal wing, including the presence still of the first digit. In accordance with this great transformation, the Penguin differs from all other birds in its mode of swimming and diving. The paddles work with a rotary motion after the manner of the wing in flight, and the feet, instead of contributing to the progress, are stretched out stiffly backwards as in a flying bird. Yet from the bones of the pelvic girdle and the webbing of the feet Pycraft deduces that the Penguin originally swam with its feet and used its wings merely to help its progress, after the manner of the Auks.

The use of the wing as a weapon of offence is far less important. Its use thus is probably best known amongst the Pigeons and Doves which strike at each other with their wings when fighting in a desultory and ineffective way. Some birds like the Jacanas (*Parridæ*), the Spur-winged Plovers (*Hoplopterus*) and the Red-wattled Lapwing (*Lobivanellus indicus*) possess a horny spur on the carpal joint, and it is commonly stated that they use the spur as an offensive weapon, though I have never seen any proof of the fact.

Any discussion of wings and flight seems incomplete without some mention of the tail, though I cannot help feeling that the tail is not so completely an appanage of flight as we are accustomed



THE PADDLE OF A PENGUIN
to show the bones of the hand and wrist
(after Pycraft).

to think it. We have got to remember its origin. We have already seen (Vol. XXXIII, p. 172) that in *Archæopteryx* the tail was quite distinct in appearance from that of the modern bird. It was a long tapering organ of about twenty-one vertebrae and from each of the last 13 or 16 vertebrae sprang a pair of well developed feathers, one on each side of the bone. This tail at once suggests to us the tail of a reptile with the addition of feathers, which of course it is. It also explains the construction of a modern bird's tail. This consists of five to eight free vertebrae, followed by the fusion of six to ten others into a bony plate known as the *Pygostyle,* which supports the fan of tail feathers. To put it briefly, some of the vertebrae have been lost and the others have telescoped together, the opposing pairs of feathers being thereby drawn into a fan.

The reason for the change seems obvious. To a reptile a long heavy tail must be a valuable fulcrum inducing to quickness of movement. To a reptile inclining to an upright position and to the arboreal life with tendencies to a parachuting flight, a long heavy tail must still be of value both as a fulcrum and as an aid to balance. But to the bird of perfect flight, gained by the adjusting of balance and gravity to the use of light feather wings a long vertebral tail could only be a hindrance; muscular power and energy would be expended in keeping it horizontal in flight; its weight so far behind would upset the other needs of gravity and flight. And if its feathers could take its place they would serve just as well for all the purposes of balance and steering. And this is what has happened.

The feather tail of a bird is an extremely variable and mobile organ; we find it in all sorts of shapes and sizes, long and short, broad and narrow, heavy and light. The feathers are modified for special uses as in the woodpeckers and tree-creepers where it supports the birds against the tree trunks they climb; they are adorned and modified for sexual displays both by colour and form; where they are not required as in the Grebe and the Bustard-Quail, they are cut down to an absolute minimum. But in all guises and forms the tail remains not an instrument of flight, for it is just as important to the walking or perching bird, but an instrument of balance. The tail is used in flight of course—one has only to watch the Pariah Kite (*M. m. govinda*) soaring above the bazaar to see that the feathers are in a constant state of movement. But it is not a necessary concomitant of flight. Pull out the tail feathers and the bird will not be disabled from flight. It is the balancing pole serving to emphasize the steering done by the primaries and head. With the tail the bird can perform its aerial evolutions more cleanly; without the tail it can still perform them.

(To be continued)

FLOWERLESS PLANTS

BY

M. ROBINSON, B.A. (T.C.D.), NAT. SCI. TRIP. CAM.

PART III

THE LICHENS

(With one coloured and two black and white plates)

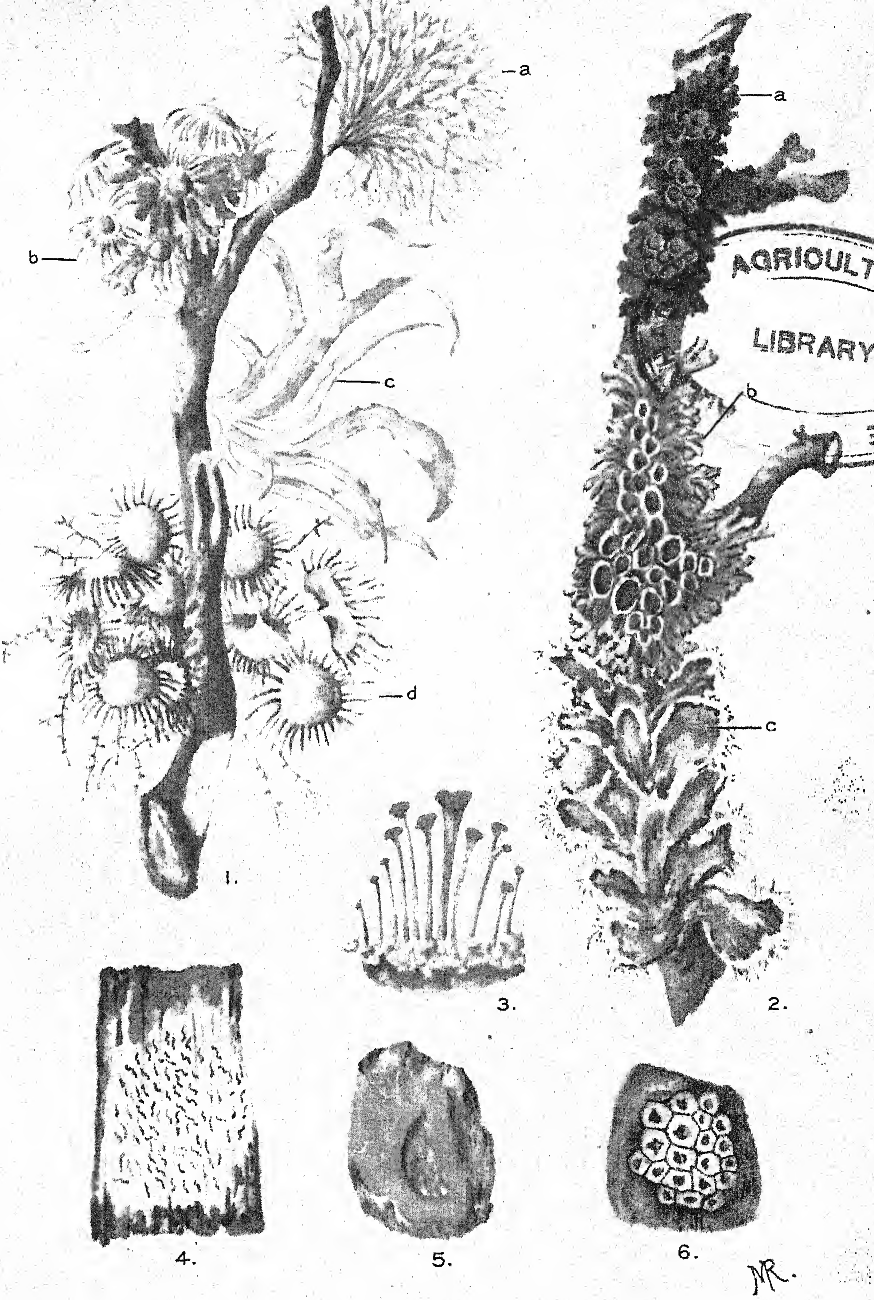
(Continued from page 799 of Vol. XXXIII)

The Lichens form the third group, a large and well defined one, of the Cryptogams. They are plants of lowly organization, having affinities with both the algae and the fungi, and their structure is peculiar and unlike anything else in the plant-world. On this account, and from the fact that they have a world wide distribution and will grow on anything, they are a very interesting group to study.

The collector may look anywhere and everywhere for lichens, and will seldom be disappointed. Trees, rocks, old walls and palings, dry banks of earth and wet mosses, all offer a habitat to these cosmopolitan little plants. No place seems too hot or dry, no place too cold or wet for them. On the bare stems of the palmyra palm in the plains; on bare rocks exposed all day to the burning heat of the sun, or to the spray of the waves that beat ceaselessly upon the sea-shore; on the damp tree trunks, and among the mosses of tropical forests; and even in the icy desolation of the arctic regions where no other plants can live, lichens will be found. They are the pioneers of vegetation, and appear first among plants to clothe a bare hillside or rock face with their white or grey or orange incrustations, and their little fairy-like bushes of creamy white or gold.

The vegetative body or thallus of a lichen shows much variation in form and texture, and all lichens are very much affected by the presence or absence of water. When moist, some are gelatinous, others merely soft in texture, all becoming dry, and hard or leathery, when the atmosphere or substratum contains little moisture. They do not die, but seem to be in a state of rest, and rapidly absorb moisture, and resume their active growth, when water is available. They can thus stand a long period of drought without perishing. The colour is also affected, as when dry most lichens are white or grey or brownish, becoming green, or grey-green or a dark olive green when wet. The orange coloured lichens do not show this change of colour to the same degree.

The form of the thallus may be one of three main types. The *Crustaceous*, the *Foliose* or *leafy*, and the *Fruticose* or *shrubby* type



FLOWERLESS PLANTS. LICHENS.

FIG. 1. A twig bearing four typical fruticose lichens.
(a) *Teloschistes flavicans*. (c) *Usnea articulata*.
(b) *Anaptychia* sp. (d) *Ramalina* sp.

FIG. 2. A twig bearing three typical foliose lichens.
(a) *Pannaria pezizoides*. (b) *Parmelia* sp. (c) *Parmelia* sp.

FIG. 3. *Cladonia bacillaris*.

FIG. 4. A crustaceous lichen on bark, one of the order *Graphidineæ* with linear fructifications.

FIG. 5. A crustaceous saxicolous lichen with orange thallus.

FIG. 6. A crustaceous saxicolous lichen with thallus divided into more or less regular segments.

(All figures natural size.)

and it is usual to distinguish three groups of lichens according to the form of their thallus.

1. *Crustaceous Lichens* (Pl. I, Nos. 4, 5, 6; Pl. II, Nos. 4—9). These, as the name denotes, spread over the surface of the substratum like a thin dry crust, smooth and shining, or rough and warty. They are found on bare hard rocks, or the bark of trees, and on old palings and walls, and individual plants form more or less circular patches of varying size, though a number may meet and form large irregular patches with no differentiating lines. The thallus is dorsiventral, that is, it has an upper and a lower surface, the upper surface being usually white or grey, becoming greenish when wet, or bright orange yellow. The under surface is very dark brown or black, and is generally firmly embedded in the substratum, so that it is extremely difficult to remove such lichens, and it is usually necessary to chip off a piece of the rock or tree, to add it to one's collection. On the upper surface of the lichen are seen little round discs or nodules, scarlet or black, grey or yellow, which are the fructifications of the lichen. In some species they are long and narrow, like little black or grey streaks, and are then known as *lirellae*.

2. *Foliose Lichens* (Pl. I, No. 2; Pl. II, Nos. 1, 2, 3). These are also dorsiventral in structure, but of a more spreading and leafy nature, and while adhering more or less firmly to the substratum, curl and twist away from it at their edges, and are much more easily detached. The thallus is lobed and branches dichotomously resembling the red and brown algae in this characteristic. The lobes may be large or very small, broad and rounded as in Pl. II, fig. 1, or narrow giving a strap-shaped thallus as in fig. 2; the thallus may be flat with the lobes overlapping, or may curl and twist fantastically, showing in fact a wide variety of form. In some the lobes are so small that the thallus at first sight seems to be crustaceous, the lobes only being visible with a lens. They are then known as *squamules* and the thallus is said to be *squamulose*.

The under side is always dark brown or black, and often bears long or short black hairs, which clothe the edge with a fringe, and act as organs of attachment; they are also thought to absorb moisture from the air. The upper surface is white, yellowish grey or bluish grey, dark brown or black, always becoming more greenish when moist and is generally smooth and sometimes rather powdery. A few genera have the upper surface marked with regularly arranged criss-cross ridging, so that it rather resembles the skin of a snake or lizard. The fruits are generally open cup shaped structures of fairly large size, and are scattered over the upper surface, or on the edges of the thallus.

3. *Fruticose Lichens* (Pl. I, fig. 1 a, b, c, d). These have an upright or trailing, branched, thallus which is only attached to the substratum by one point or root. The branching is in the main dichotomous, though little side branches are often given off from the main stems. The thallus is radial in structure and is either cylindrical as in *Usnea* and *Thelochistes*, or strap-shaped as in *Ramalina* and *Anaptychia*. *Ramalina* and *Usnea* resemble dainty little bushes of creamy white, *Anaptychia* is bluish grey; the bright

6

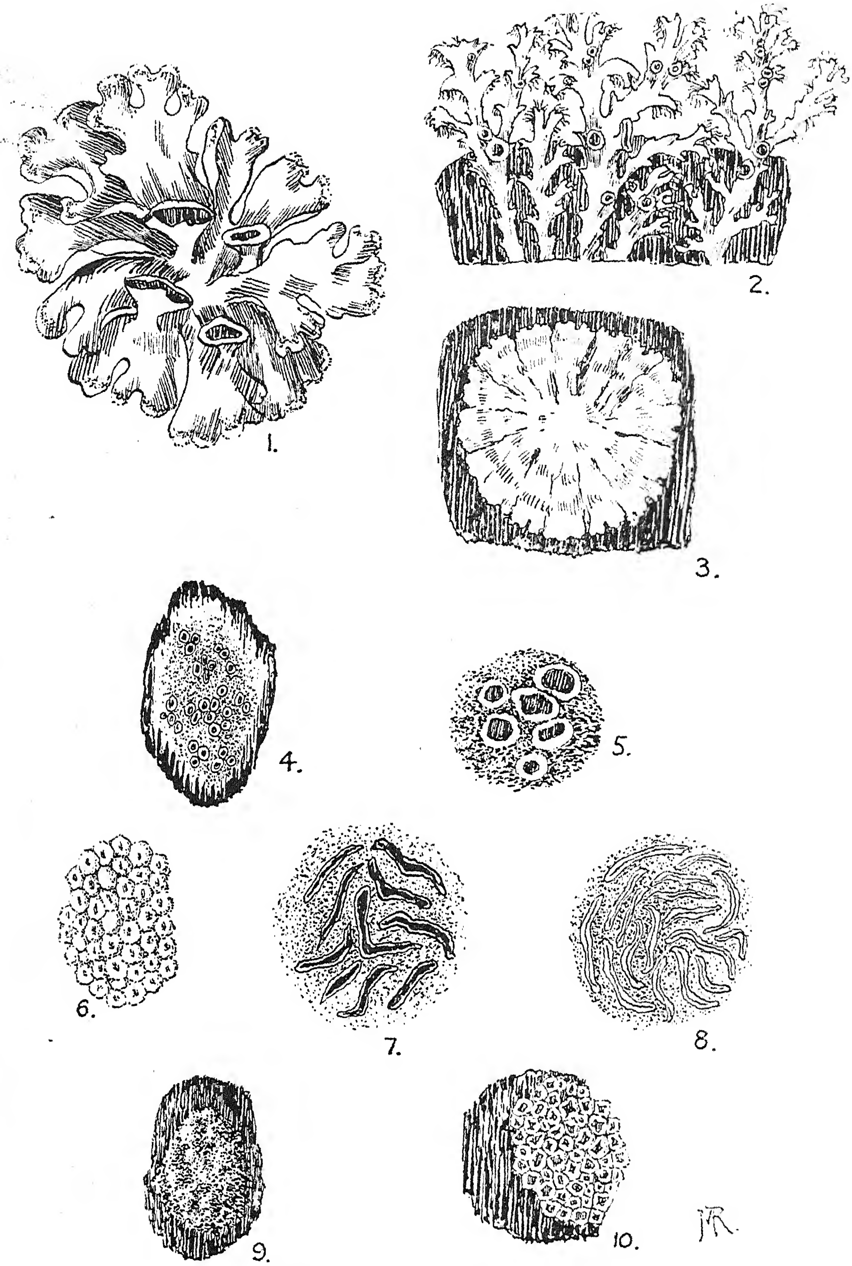
orange tufts of *Thelochistes* are common on the bare twigs of Rhododendrons and many other jungle trees. Bunches of *Usnea articulata* hang from branches of trees, and trail down the face of a rock, reminding one of long-straggling beards of matted, tow-coloured hair, and are aptly described by their name of 'old man's beard'. The fruits are rather fleshy nodules, growing at the edge of the thallus as in *Ramalina* or at the fork of the thallus as in *Thelochistes,* or they are flattened leathery discs, generally fringed with hairs or star points as in *Usnea* and *Anaptychia* and other genera.

A fourth type of thallus which is usually known as the *Cladonia* type, from the fact that it occurs in the genus *Cladonia,* has some of the characteristics of both the last two types. Here the primary thallus is minutely foliose or squamulose and often buried in the substratum, though in several genera the small leafy segments are visible above the ground. On this thallus arise long-stalked structures known as *podetia* which bear the fructifications at the top. They are sometimes considered a stalked fructification on a foliose thallus, or more usually now, are regarded as a secondary thallus of the radial fruticose type which bears the fructifications.

The podetia are sometimes simple unbranched stalks tapering to a point, sometimes they are branched, the tips become enlarged and coloured fructifications, scarlet, brown or black appear (Pl. I, fig. 3), while in a third species the podetia spread out upwards and become trumpet-shaped, the edges being often fringed. These little podetia are often about an inch high, and covered with a delicate grey-green powdery bloom. A group of little 'trumpets', or pointed 'candles', or of bright scarlet-headed stalks, looks like some veritable little fairy-plant, standing up stiffly among the dark green mosses, on the old decaying tree trunks which are their favourite habitats.

The internal structure of a lichen

It was stated above that the lichen plant had a peculiar and unique structure. This cannot be seen without a microscope, but if a part of the thallus of a lichen is examined under a fairly high-power lens, the astonishing fact is revealed that the thallus is made up of two entirely different and distinct plants, one an alga and one a fungus, living together in perfect harmony and interdependence, and producing by their association, a plant which is entirely different from either of them. If the two are separated, the alga can continue a separate existence as an alga, the fungus as a fungus; brought together again the fungus threads surround the algal cells, and a lichen thallus is formed. Neither partner is parasitic on the other in the ordinary sense of the word; on the contrary, each derives benefit from its association with the other, and each carries on its own special functions to their mutual benefit. The alga which contains chlorophyll, supplies to the fungus, and the lichen, the products of the processes of assimilations and photosynthesis which take place within its cells. These processes which were described in the first paper of this series result in the formation of carbon compounds from the free carbon-dioxide of the air and



FLOWERLESS PLANTS. LICHENS.

FIG. 1. A species of *Parmelia* with broad lobed thallus, large stalked cup fructifications and soredia on the margins.
FIG. 2. Another species of *Parmelia* with narrow ribbon-like thallus with black hairs on under side, medium-sized fructifications.
FIG. 3. A third species of *Parmelia* with thallus almost like a crustaceous lichen.
FIG. 4. A crustaceous lichen on bark, white thallus with bright scarlet centres to cups.
FIG. 5. The same magnified 10 times.
FIG. 6. A portion of the thallus of the orange lichen shown in Plate I, Fig. 5, magnified 10 times.
FIG. 7. The thallus of the lichen shown in Plate I, Fig. 4, magnified 10 times.
FIG. 8. Another species of the *Graphidineæ*, magnified 10 times, showing somewhat different linear fructifications.
FIG. 9. A saxicolous lichen, natural size.
FIG. 10. A portion of the thallus of the same magnified 10 times.

take place under the influence of bright sunlight, and in the presence of chlorophyll. The fungus which contains no chlorophyll thus receives these products which it would otherwise have to obtain elsewhere, and in return attracts and holds moisture and dissolved salts, and passes them on to the alga, held and protected by its encircling hyphae. Such an alliance of two partners with mutual benefit to both is known as *symbiosis* which means literally '*a living together*' and the lichen plant affords a perfect and unique example. A section through part of the thallus of the lichen *Collema* which is a foliose lichen, and gelatinous when wet, will show as in Pl. III, fig. 1, the little chains of cells of the alga *Nostoc,* one of the blue green algae, scattered about everywhere among the fungal hyphae. In fig. 3, the section is taken from a *Parmelia* and shows that here the alga, which is one of the bright green algae, is confined to a definite layer just below the surface, and not scattered indiscriminately throughout the thallus. This arrangement is found in most of the more highly developed lichens of the foliose and fruticose type. In addition to their vegetative functions, such as assimilation and absorption of water, each partner carries on its own methods of reproduction. The alga divides up into spores, producing what are called *gonidia* so that the algal layer in the lichen is sometimes called the *gonidial layer.* The gonidia can only be seen under a high power of the microscope.

The fungus constituent almost always belongs to the group *Ascomycetes.* The few exceptions are found in rare tropical lichens and belong to the *Basidiomycetes,* both *Hymenomycetes* and *Gasteromycetes* being represented. It is not always possible to trace the fungus back to any particular species or genus, certain modifications having been produced as a result of its symbiotic life in the lichen thallus. The main characteristics, however, are those of the *Ascomycetes* or the *Basidiomycetes* and the spores of the fungus are produced in one case in an ascus, in the other on a basidium. These are borne in the usual way, grouped with paraphyses, in a special fructification which is disc-like or cup-shaped in the *Ascomycetes* or takes some from characteristic of the *Basidiomycetes.* These fructifications are large enough to be seen with the naked eye, and the cups and discs which have already been noted as the fructifications of the lichen, are indeed those of its fungus constituent. These fructifications are taken as the basis of classification of the lichens, and we get, therefore, the two main groups of the *Ascolichens* and *Basidiolichens.*

The *Ascolichens* are divided into two series—

1. The *Gymnocarpeæ* where the fruit is an open disc-like structure or cup known as an *Apothecium.*

2. The *Pyrenocarpeæ* where the fruit is a more or less closed flask-shaped structure known as a *perithecium.*

The *Gymnocarpeæ* contain the larger number of natural orders, genera and species and include families in which the apothecium is disc-like as in *Usnea* and *Anaptychia* (Pl. I, fig. 1) or cup-shaped as in *Parmelia* and *Pannaria;* (Pl. I, fig. 2) and (Pl. II, figs. 1, 2 and 4) or in the form of lirellae the narrow streak-like fructification of the *Graphis* (Pl. I, No. 4 and Pl. II, Nos. 7 and 8). There is also a

small family including *Calicium* and *Sphærophorus* in which the apothecium is partially closed and is usually globular on a short stalk, resembling a small nail or a top, the whole being covered by a powdery bloom. In the *Pyrenocarpeæ* the thallus is almost always crustaceous, and often thick and rough and divided into more or less regular segments with the perithecium appearing in the centre as a small wart-like protuberance (Pl. II, Nos. 6, 9 and 10). In some cases the thallus is entirely submerged in the substratum, only the perithecia being seen as little pores on the surface.

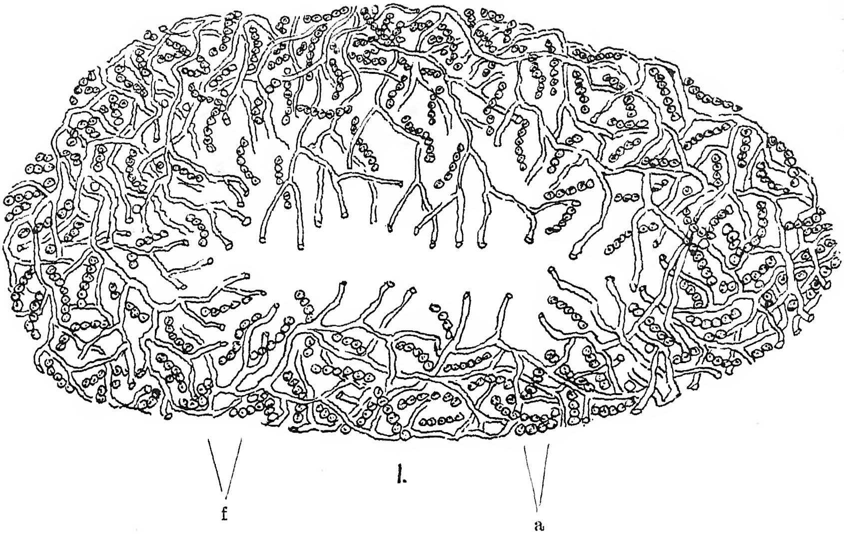
The sub-division of these two groups into natural orders, genera and species, depends upon the characters of the apothecia and perithecia, the nature of the spores, and also on the genus of the alga found in the thallus, and on the vegetative character of the thallus. The fungus spores, liberated from the asci when ripe, germinate under favourable conditions and send out hyphae in the usual manner. These hyphae coming in contact with algal spores, liberated from the gonidia, will rapidly invest them and a new lichen thallus is started.

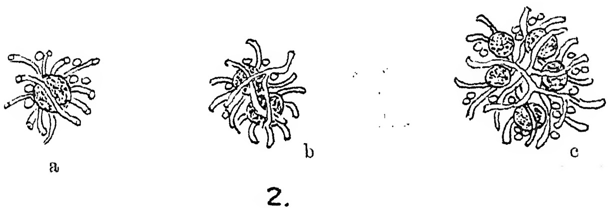
Another way in which lichens propagate themselves is a vegetative method. Here parts of the actual thallus break down into a fine powdery mass, each grain of the powder containing one or more algal cells already invested with its fungal hyphae. This fine white powder is almost always present on a lichen thallus, both of the foliose and fruticose type and can readily be seen, sometimes collected in definite regions, such as the edges of the lobes, or in little ridges or swellings on the thallus, sometimes scattered indiscriminately over the thallus. These vegetatively formed bodies are known as *soredia* and are shown highly magnified in Pl. III, fig. 2, starting to develop into a lichen thallus.

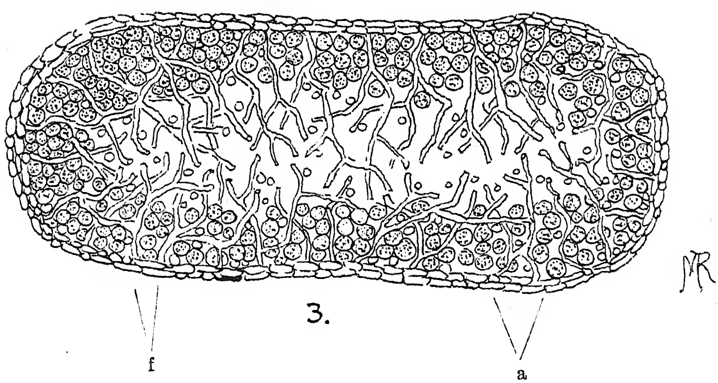
The lichen, for its best development, must be exposed to bright light, as the algal cells are situated well inside the thallus and below a protecting layer of fungal hyphae. We shall find lichens at their best then at the edges of woods rather than in the shady depths of the forest, and on the most exposed rocks and open hillsides. The climate of most Indian hill stations with abundant rain and plenty of sunshine is particularly favourable to their development, and they will be found in great variety in such localities. Different species usually prefer a different substratum; certain species that are found on very hard rock, for instance, and are known as *saxicolous* lichens, are not found on wood. On the other hand, many kinds may choose the same substratum, as fourteen different species, belonging to almost as many genera, were found on the same branch of a peach tree, in a garden near Kodaikanal in the Pulni Hills.

These lowly little plants, and more particularly the saxicolous lichens play an important part in the economy of nature, by carrying on the first stage in the formation of soil and humus. They settle upon the hardest and most barren of rocks, that are inhospitable to all other kinds of plants, and slowly but surely eat their way into them, as they cover the surface with their spreading crustaceous thalli. They thus start disintegration, gradually breaking down the rock to a condition more favourable to the growth of other plants.

From an economic point of view, lichens are not now of very







FLOWERLESS PLANTS. LICHENS.

FIG. 1. A section through the thallus of *Collema*, a gelatinous lichen. The blue green alga *Nostoc*, a, is mixed indiscriminately throughout the thallus with the hyphæ of the fungal constituent, f. Magnified about 250 times.

FIG. 2. Stages in the development of a thallus from soredia of a *Parmelia*.
(a) One algal cell, *Protococcus*, surrounded by fungal hyphæ.
(b) The algal cell has divided into two.
(c) Several algal cells now invested with fungal hyphæ.
Magnified about 250 times.

FIG. 3. Section through the thallus of a *Parmelia* showing the algal cells of *Protococcus* confined to a definite layer immediately below the surface of the thallus. Magnified about 150 times.

much use, though two or three are still used on a commercial scale for the production of dyes. In olden days, they were very extensively used among country people, in many parts of Britain, particularly in Scotland, where a great variety of dye lichens were known and used. This form of home industry is now vanishing rapidly owing to the introduction of chemically produced aniline dyes, but there are still a few districts in which it lingers. The famous 'Harris' tweed owes its familiar yellow-brown colour and characteristic smell to the dye with which it is treated. This is produced from a lichen, which grows in large quantities in Scotland, and is a species of Parmelia (*P. saxatilis*). It is known locally and commercially as 'crottle'. As the dye is rather uneven, the fleece is boiled up with the lichen, a small quantity of an alkali, either ammonia or potassium carbonate, being added to help the extraction of the dye. The unevenness of the dye can then be disguised by mingling the various shades in the processes of carding and combing which precede spinning. Several other species of *Parmelia* are also used to give a brown dye. Other species of lichens which include *Ramalina scopulorum, Lecanora pallescus,* and one or two others are used to give various shades of red, blue and purple dyes, but these all require a long process of fermentation with water and an alkali, before the dye can be extracted, and are troublesome to use. The lichen *Lecanora tartarea* known commercially as '*korkir*' is used to produce 'cudbear' a beautiful foxglove purple dye. Another well-known and useful purple dye commercially produced from a lichen, is 'orchil', or litmus, used so largely in the laboratory, on account of the property it has of becoming red in the presence of an acid, and blue with an alkali. It is made from *Roccella tinctoria* one of the earliest recorded lichens, which is found in great abundance along the Mediterranean coasts.

A few lichens such as the Iceland Moss (*Cetraria Islandica*) are used as food in places of great scarcity, but they are unpleasantly acid to the taste, and of a tough and leathery consistency. In northern regions, vast tracts of country are covered by the well-known 'Reindeer Moss', which is also not a moss but a lichen (*Cladonia rangiferina*) and this provides extensive grazing grounds for the wandering herds of the tundras.

The writer would like to acknowledge here with grateful thanks the help received from Miss Lorrain Smith, F.L.S., whose *Handbook of the British Lichens* should be the *vade mecum* of all those interested in lichens; and also help from Mr. R. D. Anstead, C.I.E. in the identification of several species.

NOTES ON THE BIRDS OF THE UPPER BURMA HILLS

BY

P. F. Wickham

PART II

(*Continued from page 827 of Vol. XXXIII.*)

XVIII.—Family Irenidæ

327. **The Fairy Blue Bird. Irena puella puella.**

An inhabitant of all these hills, but nowhere so common as I found it on the sea coast of Arakan. I think these birds collect in numbers where food is available and are not then at all shy.

XIX.—Family Oriolidæ

328. **The Indian Black-naped Oriole. Oriolus chinensis indicus.**

329. **The Burmese Black-naped Oriole. Oriolus chinensis tenuirostris.**

Both subspecies *indicus* and *tenuirostris*, the Indian and Burmese Black-naped Orioles appear to occur in the Kachin and Shan Hills. The *Fauna* says the latter was found 'Breeding by Hopwood at Monywa in Upper Burma between 3,000 and 4,000 ft.' Monywa, I may say, is in the plains, it should probably read Maymyo, but Hopwood recorded it from the North Chin Hills at 3,000 ft.

330. **The Indian Black-headed Oriole. Oriolus xanthornus xanthornus.**

Probably the commonest oriole in these hills. It breeds in May and June, the nests are difficult to get at as they are slung at the end of thin branches, but as the parent birds show great anxiety when the nest is approached, they are not difficult to find. I have generally heard them called by Burmans 'Hnet Wa' or yellow bird.

331. **The Maroon Oriole. Oriolus traillI.**

Occurs throughout these hills, a very shy bird.

XX.—Family Eulabetidæ

332. **The Indian Grackle. Eublabes javana intermedia.**

To be found in all our hills, generally in large parties in heavy jungle. I only took this bird's nest in the Andamans, a different subspecies. I have always considered they give the parrot points as 'cage bird' mimics.

333. **Hodgson's Glossy Stare. Lamprocorax panayensis affinis.**

Kachin and Shan Hills. Seems to have been missed by Harington in the former and I can only say I have seen it in the Shan Hills, but very rarely.

334. **The Assam Spotted Stare. Saroglossa spiloptera assamensis.**

Chin, Kachin and Shan Hills. I never came across it myself.

XXI.—Family Sturnidæ

335. **The Grey Starling. Spodiopsar cineraceus.**

Recorded by Harington from the plains of the Kachin Country.

336. **The Grey-headed Myna. Sturnia malabarica, malabarica.**

Chin Hills.

337. **The White-winged Myna. Sturnia malabarica nemoricola.**

Kachin and Shan Hills, but more an inhabitant of the plains than hills.

338. **The Gold-crested Myna. Ampeliceps coronatus.**

As this bird is found in Eastern Bengal and Assam, it is probable it occurs also in these hills although apparently not recorded.

339. **The Black-necked Myna. Gracupica nigricollis.**

Kachin and Shan Hills. A familiar bird on any lawn. It is very interesting and amusing to watch the family following father and mother on the grass and being fed. The nest is the most untidy large collection of material one can imagine but I daresay a very snug nursery. Breeds in April and May laying 4 or 5 eggs.

340. **Jerdon's Myna. Gracupica burmanica.**

Chin, Kachin and Shan Hills, a provincial bird, and exceedingly common. It is surely more than one inch shorter than *nigricollis*.
A typical myna in all its habits.

341. **Wells's Myna. Gracupica leucocephala annamensis.**

A Northern Shan States subspecies. Seems rather questionable.

342. **The Common Myna. Acridotheres tristis tristis.**

Ubiquitous, but is a 'House' bird.

343. **The Indian Jungle Myna. Æthiopsar fuscus fuscus.**

Chin Hills.

344. **The Assam Jungle Myna. Æthiopsar grandis infuscatus.**

Kachin and Shan Hills. Breeds in tree holes, as a rule, about middle of April, but its nesting in river banks has been recorded.

345. **The Collared Myna. Æthiopsar albocinctus.**

Commoner in the plains than the hills, according to Harington in writing of the birds round Bhamo (Kachin Hills) but in the Shan Hills it is quite a common bird ; the nesting of this bird in river banks has been recorded, but tree hollows are generally used.

346. **The Burmese Pied Myna. Sturnopastor capensis superciliaris.**

Chin, Kachin and Shan Hills. Fairly common but commoner in the plains.

XXII.—Family Ploceidæ

347. **The Eastern Baya. Ploceus passerinus passerinus.**

An inhabitant of the lower valleys in these hills. The naturalist in North Burma, measuring his specimens very carefully, might find he has acquired the other subspecies *infortunatus*. I have often seen its nest attached to the thatch roof eaves.

348. **The Burmese Striated Weaver Bird. Ploceus manyar peguensis.**

Distribution as in the case of the Eastern Baya, but the species does not seem to vary in size. The Burmese subspecies is distinguished by its richer and darker colouration.

349. **The Northern Chestnut-bellied Munia. Munia atracapilla rubronigra.**

Fairly common in suitable parts of the Chin, Kachin and Shan Hills. I cannot say I have noticed its partiality to nest in comparatively lofty trees ; my experience is that the description of the nesting of the subspecies *atricapilia*, applies to our bird also and the nearer water the better in their opinion. June, July and August are the breeding months.

350. **Hodgson's Munia. Uroloncha striata acuticauda.**

Is our common 'white-backed' munia, but in the Eastern Shan Hills the subspecies *squamicollis* is found.

351. **The Burmese Spotted Munia. Uroloncha punctulata subundulata.**

Probably the Chin Hills and Western Kachin Hills subspecies. I shot a specimen near Thunggyi and concluded this was the bird of this locality. This Munia breeds normally much higher up than the Chestnut-bellied Munia and the Rangoon birds frequently use street lamp-posts and under the eaves of houses as sites for the conglomeration of grass which serve them as nests. I think these birds build two nests to house the large family when they get too big to squeeze into the original nursery as they roost in the nests long after they are ' weaned.'

352. **The Chinese Spotted Munia. Uroloncha punctulata topela.**

Eastern Kachin and Shan Hills.

353. **The Burmese Red Munia. Amandava flavidiventris.**

Fairly common where they occur at all, i.e., in suitable grass plains. For a munia's, it is really rather a difficult nest to find and I have seldom seen one off the ground.

XXIII.—Family FRINGILLIDÆ

354. **The Spotted-winged Grosbeak. Mycerobas melanoxanthus.**

Must be a rare bird in our hills as our elevations are not suitable.

355. **Rippon's Bullfinch. Pyrrhula erythaca altera.**

Shan States.

356. **The Mount Victoria Bullfinch. Pyrrhula nipalensis victoriæ.**

S. Chin Hills.

357. **The Yunnan White-browed Rose-Finch. Propasser thura femininus.**

Shan Hills.

358. **Sharpe's Rose-Finch. Propasser ripponi.**

Shan Hills.

359. **The Vinaceous Rose-Finch. Propasser vinaceus vinaceus.**

Kachin and Shan Hills.

360. **The Common Indian Rose-Finch. Carpodacus erythrinus roseatus.**

Probably the subspecies that visits us in winter in the eastern hills, Shan and Kachin. The birds go about in small flocks in cultivated and open country. I shot the species at the end of February at Maymyo, Shan Hills, east of Mandalay. They are not uncommon all over the Southern Shan States. Its occurrence is also recorded by Col. Rippon from Bhamo (Kachin Country).

361. **The Yunnan Dark Rose-Finch. Procarduelis nipalensis intensicolor.**

Shan Hills, evidently rare.

362. **The Yunnan Green-Finch. Hypacanthis spinoides ambiguus.**

Cook obtained this bird at Kalaw where I also obtained it but have never seen it anywhere else. Both Cook and Grant also found it nesting. There was a small party of them which came down to feed on the grass seeds round residences and when I shot one I thought it was the Himalayan Greenfinch (*Carduelis caniceps*). Although it did not quite tally, it was very pleasing to hear of its identification later. Our finches are so rare and few that one rejoiced to see them about the place and it is very curious they do not seem to spread or increase in numbers.

363. **The Yellow-throated Sparrow. Gymnoris xanthocollis xanthocollis.**

Recorded from the Kalaw, S. Shan States by Sir S. M. Robinson. After the recording of this bird I continually put my glasses across likely looking sparrows in these parts, but was never decided I had seen a *Gymnoris* and never managed to bag one.

364. **The Burmese House-Sparrow. Passer domesticus confucius.**

Ubiquitous. The *Fauna* says it turns out the Tree Sparrow ; that is not my experience, perhaps in the province it is named after, it behaves better.

365. **The Malay Tree-Sparrow. Passer montanus malaccensis.**

All these Burma Hills. More common than the House-Sparrow.

366. **The Cinnamon Tree-Sparrow. Passer rutilans cinnamomeus.**

Considerably less common than the preceding species of sparrows.

367. **The Yunnan Cinnamon Sparrow. Passer rutilans intensior.**

The subspecies occurring in the Shan States.

368. **The Pegu House Sparrow. Passer flaveolus.**

A Burmese bird entirely. It extends east of Burma. I do not think this bird is to be found in the Chin Hills, nor did Harington find it in the Kachin Hills, but it is very common in the Shan Hills up to 5,000 ft. A very handsome sparrow is the male bird. Breeds in any hole and quite commonly inside a bamboo which is being used as a hedge post, etc.

369. **The Grey-headed Bunting. Emberiza fucata fucata.**

370. **The Indian Grey-headed Bunting. Emberiza fucata arcuata.**

The subspecies *fucata* and *arcuata* occur in our hills as winter visitors.

371. **The Little Bunting. Emberiza pusilla.**

A winter visitor to these hills. I procured a specimen myself east of Mandalay at Maymyo. Shan Hills.

372. **The Yunnan Meadow-Bunting. Emberiza cia yunnanensis.**

Said to have occurred in the Shan States, but a doubtful record, as a hill, of 10,000 ft. as far as I am aware, does not exist in Shan land.

373. **The Yellow-breasted Bunting. Emberiza aureola.**

Rather a late winter migrant to the Shan States. It stays till the end of April when the male bird has begun to assume its breeding plumage and becomes a very conspicuous individual.

374. **The Chestnut Bunting. Emberiza rutila.**

Chin, Kachin and Shan Hills as a winter visitor.

375. **The Crested Bunting. Melophus melanicterus.**

A very universal bird in all our hills and our one solitaty bunting to breed. Habits and nidification very nicely described in the *Fauna*, but I have noted what I called its short plaintive song from the top of a bush in the breeding season.

XXIV.—Family Hirundinidæ

376. **The Eastern Sand-Martin. Riparia riparia ijimæ.**

Perhaps this bird does not occur in our hills.

377. **The Indian Sand-Martin. Riparia paludicola chinensis.**

I am rather confused, but I always thought this was our Sand-Martin throughout Burma. Begins to breed in April in colonies which perhaps sometimes consist of only 2 or 3 nests.

378. **The Crag-Martin. Ptyonoprogne rupestris.**

There is a small Crag-Martin which inhabits the Taunggyi Crags, Shan Hills about 5,000 ft. I failed to get a specimen through bad shooting with a 23 bore so I am not sure which species it is. It always hawked for insects round the rocky parts and I never met with it away from them. There were only a few, but I think were permanent residents.

379. **The Eastern Swallow. Hirundo rustica gutturalis.**

380. **Tytler's Swallow. Hirundo rustica tytleri.**

Both winter visitors to our hills. Col. Rippon seems to have recorded the subspecies *rustica* from round Bhamo, Kachin Hills.

381. **The Indian Wire-tailed Swallow. Hirundo smithii filifera.**

A common bird in our hills. Begins to breed at end of March and goes on throughout the rains.

382. **The Chinese Striated Swallow. Hirundo daurica striolata.**

A permanent resident in the Shan Hills at any rate and probably also in the Chin and Kachin Hills.

It breeds in the Shan Hills making its retort-shaped mud nests, against the ceiling of rooms and verandahs of buildings and up against the roofs of caves in the limestone rocks. Sometimes just the one nest, but often in the case of the caves a few pairs may be found nesting together. If the nest is destroyed, as sometimes it is a nuisance, they often build again in the same place. Dry grass is often used as lining. I have never seen any eggs with spots, five is the usual number, and nesting begins at the end of April.

383. **Sykes's Striated Swallow. Hirundo daurica erythropygia.**

Mackenzie records this subspecies from the North Chin Hills.

XXV.—Family MOTACILLDÆ

384. **The Indian White Wagtail. Motacilla alba dukhunensis.**

Recorded by Rippon in the Kachin Hills.

385. **The Masked Wagtail. Motacilla alba personata.**

I have shot one in the Shan Hills, or rather I pounced on a specimen shot by an urchin with a pellet bow.

386. **Swinhoe's White Wagtail. Motacilla alba baicalensis.**

Is also a Shan Hills bird.

387. **The Streak-eyed Wagtail. Motacilla alba ocularis.**

Probably Shan Hills, all of course being winter visitors only.

388. **Hodgson's Pied Wagtail. Motacilla lugubris alboide.**

389. **The White-faced Wagtail. Motacilla lugubris leucopsis.**

Both recorded as wintering in Burma as a whole.

390. **The Eastern Grey Wagtail. Motacilla cinerea caspica.**

Another winter visitor.

391. **The Grey-headed Wagtail. Motacilla flava thunbergi.**

Probably a winter visitor to all three hills. Recorded by Harington in the Kachin Country.

392. **Hodgson's Yellow-headed Wagtail. Motacilla citreola calcarata.**

Winter visitor. Recorded by Harington as occurring in the Kachin Country.

393. **The Forest Wagtail. Dendronanthus indicus.**

Occurs sparingly throughout our hills. A lonely bird.

394. **The Indian Tree-Pipit. Anthus hodgsoni hodgsoni.**

395. **The Yunnan Tree-Pipit. Anthus hodgsoni yunnanensis.**

Both winter visitors to the Burmese Hills, the latter in the East. Small parties of 8 or 10 birds feed on the ground and when disturbed, fly up into trees ; partial to well watered country.

396. **The Brown Rock Pipit. Anthus sordidus jerdoni.**

Winters in the Chin, Kachin and Shan Hills.

397. **Richard's Pipit. Anthus richardi richardi.**

398. **Blyth's Pipit. Anthus richardi godlewskii.**

Apparently both subspecies *richardi* and *godlewskii* occur in the Burma Hills, but evidently, by their description of them in the *Fauna*, the two may perhaps turn out to be one subspecies. I found the bird breeding about 3,000 ft., in the Shan Hills, but only found young.

399. **The Indian Pipit. Anthus richardi rufulus.**

A very common bird which inhabits nearly every open grass space, and breeds where it lives. I found the nest of this bird very often contained the egg of *Cuculus canorus*.

400. **The Red-throated Pipit. Anthus cervinus.**

Occurs throughout our hills.

401. **The Japanese Water-Pipit. Anthus spinoletta japonicus.**

Recorded as nesting on Mt. Victoria, S. Chin Hills.

XXVI.—Family ALAUDIDÆ

402. **The Small Indian Sky-Lark. Alauda gulgula gulgula.**

403. **The Small Chinese Sky-Lark. Alauda gulgula cœlivox.**

The two subspecies, *gulgula* and *cœlivox*, occur in our hills. I took some nests at about 8,000 ft. in the Chin Hills and apparently some collector obtained nests and eggs on Mt. Victoria and these eggs were identified as belonging to the latter subspecies ; so probably mine from further north belong to *cœlivox* also. The nests were typical larks' nests taken in April, in each case a clutch of three only, rather long ovals and one clutch has a very distinct ring of marking round the big end.

404. **The Rufous Short-toed Lark. Calandrella brachydactyla dukhunensis.**

Probably occurs in our hills.

405. **The Ganges Sand-Lark. Alaudula raytal raytal.**

May occur on the Irrawaddy River in the Kachin Country, but is not a hill bird.

406. **The Siam Singing Bush-Lark. Mirafra javanica williamsoni.**

I found this bird breeding in April, in the Shan Hills at about 3,000 ft. in grassy plains. Nest very similar to *Anthus. r. rufulus*, the bird being shot and skin identified for me in England : sings very like our English Lark soaring in the air.

407. **The Burmese Bush-Lark. Mirafra assamica microptera.**

A very common bird in the north of Burma in the dry zone and to be found sparingly at low elevations in the hills. Although a bird of dry and arid land in Burma, it has the same habit as the Bengal Bush Lark in 'sailing down on outstretched wings.'

XXVII.—Family ZOSTEROPIDÆ

408. **The Northern White-Eye. Zosterops palpebrosa elwesi.**

North Shan Hills, and Kachin Hills.

409. **The Cachar White-Eye. Zosterops palpebrosa cacharensis.**

Chin Hills.

410. **The Pegu White-Eye. Zosterops simplex peguensis.**

S. Shan Hills.

411. **The Siamese White-Eye. Zosterops siamensis.**

Chin Hills.

412. **The Karen White-Eye. Zosterops aureiventris mesoxantha.**

Recorded by Rippon as occurring in Southern Shan Hills north of the Karen Country.

I am probably only intimately acquainted with *Z. simplex peguensis* and its nests and eggs; a beautiful nest and a beautiful egg, but oh! how one wishes birds like this species could be more standardised in colouration! One description of their habits, etc. would do for all of them.

XXVIII.—Family Chalcopariidæ

413. **The Malayan Ruby-Cheek. Chalcoparia singalensis singalensis.**

Said to occur in the foothills of all Burmese hills. I have only come across it in the plains and mostly in Lower Burma.

XXIX.—Family Nectariniidæ

414. **The Indian Yellow-backed Sunbird. Æthopyga siparaja seheriæ.**

Harington records that *cara*, the Tennasserim Yellow-backed Sunbird was recorded by Salvadori to occur in the Kachin Country but this is seemingly a mistake. The two sub-species, *seheriæ* (the Himalayan Yellow-backed Sunbird) and one called *andersoni* (Oates) are now not separated and the bird occurs in the Kachin Hills and probably also in the Chin Hills. In the Shan Hills the subspecies has been named *viridicauda*, the Yunnan Yellow-backed Sunbird, but the separation of this bird from *Æ s. seheriæ* is doubtful. Osmaston took the eggs of this bird at Maymyo in 1915 and in 1923 I went to live in a house at that place where a pair had evidently used for sometime a creeper climbing over a sweeper's staircase to build in and the pair did so all the three years I was there. I also found another nest in the jungle which was hanging from a bracken frond. The nest is like *Leptocoma a. intermedia* in shape but differs in material used which is mostly grass. My eggs are white with dark spots at the larger end.

415. **Rippon's Fire-tailed Sunbird. Æthopyga ignicauda flavescens.**

This pretty sunbird was very plentiful on Mt. Victoria, at about 8,000 ft. but I could not find its nest. Kachin Hills.

416. **The Yunnan Fire-tailed Sunbird. Æthopyga ignicauda exultans.**

Eastern Shan Hills.

417. **Mrs. Gould's Sunbird. Æthopyga gouldiæ gouldiæ.**

Chin Hills; high elevations.

418. **The Manipur Yellow-backed Sunbird. Æthopyga gouldiæ isolata.**

Chin Hills: at lower elevations.

419. **Dabry's Sunbird. Æthopyga dabryi.**

Seems to be the Shan Hills subspecies; nest found by Sir S. Robinson (*B.N.H.S. Journal, Vol. XXIX, p. 1052*). Harington also records it from round Bhamo, East Kachin Hills.

420. **The Black-breasted Sunbird. Æthopyga saturata saturata.**

Chin, Kachin and Shan Hills. I have, I believe, seen them in the latter part of the country almost as far east as one can go before reaching China.

421. **Walden's Yellow-backed Sunbird. Æthopyga sanguinipecta sanguinipecta.**

A bird of the Kachin and Shan Hills.

422. **The Nepal Yellow-backed Sunbird. Æthopyga nipalensis nipalensis.**

Kachin and Shan Hills.

423. **Rippon's Yellow-backed Sunbird. Æthopyga nipalensis victoriæ.**

Mt. Victoria, S. Chin Hills.

424. **The Burmese Purple Sunbird. Leptocoma asiatica intermedia.**

A common bird in all these hills. A nest in my compound was hung from a rose bush. After one brood had been reared, the bird laid again and hatched

out, but the nest could not stand the strain of a second brood and it fell, to my surprise; as far as I know, no additions were made to the nest after the 1st brood had been reared. As a rule the nest, when hanging, is seldom more than a foot or two off the ground.

425. **Van Hasselt's Sunbird. Leptocoma brasiliana.**

I think a bird of the plains only. I never saw it in the Hills.

426. **The Burmese Yellow-breasted Sunbird. Leptocoma flammaxillaris flammaxillaris.**

Shan Hills, at low elevation, probably 3,000 ft. I can find no record of this bird in the Kachin and Chin Hills.

427. **The Indian Streaked Spider-Hunter. Arachnothera magna magna.**

Recorded by Mackenzie in the North Chin Hills, and Harington from the Kachin Hills. I found this bird very local in the Shan Hills and as I did not actually shoot one, it may have been the subspecies *aurata*, the Pegu Streaked Spider-Hunter, in the South. It is not common by any means and I never discovered its nest.

428. **The Little Spider-Hunter. Arachnothera longirostra longirostra.**

Rippon recorded this bird in the Kachin Hills.

XXX.—Family DICAEMÆ

429. **The Indian Scarlet-backed Flower-pecker. Dicæum cruentatum cruentatum.**

430. **The Burmese Scarlet-backed Flower-pecker. Dicæum cruentatum ignitum.**

The Indian subspecies comes down as far as the North Chin Hills and its eastern and southern limits are unknown. The Burmese subspecies *ignitum* taking its place eventually.

431. **The Burmese Yellow-vented Flower-pecker. Dicæum chrysorrheum chrysochlore.**

Harington records it from the Kachin Hills, so it doubtless extends through the Shan Hills.

432. **The Fire-breasted Flower-pecker. Dicæum ignipectum ignipectum.**

Chin, Kachin and Shan Hills. A nest I took in May contained two eggs and was built at the top of a small tree on a rocky hillside Taunggyi crags where it was plentiful.

433. **Tickell's Flower-pecker. Dicæum erythrorhynchum erythrorhynchum.**

Probably all these hills, but recorded apparently for certain in the Shan Hills.

434. **Hume's Flower-pecker. Piprisoma squalidum modestum.**

All our hills.

XXXI.—Family PITTIDÆ

435. **Phayre's Pitta. Anthocincla phayrei.**

Shan Hills.

436. **The Blue-naped Pitta. Pitta nepalensis.**

Chin Hills.

437. **The Fulvous Pitta. Pitta oatesi.**

S. Shan Hills.

438. **The Blue Pitta. Pitta cyanea cyanea.**

All these hills.

439. **The Lesser Blue-winged Pitta. Pitta moluccensis.**

I saw a Pitta once on the Taunggyi crag which I took to be this, evidently on migration, as they breed in numbers not far from Rangoon.

440. **The Green-breasted Pitta. Pitta cucullata cucullata.**

Apparently occurs in all our hills.

XXXII.—Family EURYLAIMIDÆ

I have found it difficult from my own knowledge to add to the notes given in the *Fauna* of the habits of the birds dealt with, but in the case of the Broadbills, I could not anyhow have added to them as they are a race of birds which have studiously avoided me and I have never found a nest of any of this most interesting group.

441. **Gould's Broadbill. Serilophus lunatus lunatus.**

442. **Hodgson's Broadbill. Serilophus rubropygius.**

The former recorded by Mackenzie and Hopwood from the N. Chin Hills, but it is evidently a commoner bird south of any of our hills. The same remarks apply equally to *rubropygius*—Hodgson's Broadbill.

443. **The Long-tailed Broadbill. Psarisomus dalhousiæ.**

This seems from all accounts the commonest of our hill Broadbills. As an instance of fearlessness, a friend wrote me from Bhamo to say they suddenly appeared in numbers round the courts and, uttering their whistling call, entered rooms, almost interfering with the ends of justice.

XXXIII.—Family PICIDÆ

444. **The Little Scaly-bellied Green Woodpecker. Picus vittatus myrmecophaneus.**

Chin Hills.

445. **The Burmese Scaly-bellied Woodpecker. Picus vittatus viridanus.**

446. **The Siam Scaly-bellied Woodpecker. Picus vittatus eisenhoferi.**

The subspecies of the Kachin and Shan Hills. The subspecies *eisenhoferi* probably straggles into the extreme East.

447. **The Burmese Black-naped Green Woodpecker. Picus canus hessei.**

Apparently in all these hills. Nest hole often near the ground. In one case I came across, the old bird had been killed by a rat or some similar animal which could just reach the bird to kill and eat a part of it, but not pull it out of the hole.

448. **The Eastern Himalayan Small Yellow-naped Woodpecker. Picus chlorolophus chlorolophus.**

Chin and Kachin Hills and the Northern Shan Hills.

449. **The Burmese Small Yellow-naped Woodpecker. Picus chlorolophus chlorolophoides.**

The more southerly subspecies.

450. **The Large Yellow-naped Wood-pecker. Chrysophlegma flavinucha flavinucha.**

All the Burmese Hills.

451. **The Pale-headed Woodpecker. Gecinulus grantia.**

Chin Hills.

452. **The Southern Pale-headed Woodpecker. Gecinulus viridis.**

Shan Hills.

453. **The Eastern Rufous-bellied Woodpecker. Hypopicus hyperythus hyperythus.**

Chin and Kachin Hills.

454. **The Yunan Red-crowned Pied Woodpecker. Dryobates cabinisi stressemani.**

Chin, Kachin and Shan Hills a bird evidently of the higher elevations.

455. **The Kansu Red-breasted Woodpecker. Dryobates cathparius pernyi.**

Shan States.

456. **The Stripe-breasted Pied Woodpecker. Dryobates atratus.**

All Burma Hills. At the end of March, I found it nesting on the Taunggyi crag, Shan Hills, about 5,000 ft., in a rotten stump about twelve feet from the ground.

457. **The Northern Yellow-fronted Pied Woodpecker. Leiopicus mahrattensis blanfordi.**

The Burma Hills generally.

458. **The Yunnan Pigmy Woodpecker. Yungipicus hardwickii omissus.**

Kachin Hills. (Harington).

459. **The Burmese Pigmy Woodpecker. Yungipicus hardwickii canicapillus.**

The rest of Burma and the Shan Hills. Two nests I found in the Shan States were in small (thin) rotten branches not very high up—one twelve feet and the other six feet. One contained a fully-fledged young bird (April). The other nest was opened out when I visited it a second time, but this was early May and the young birds may have flown although it did not appear so.

460. **The Red-eared Bay Woodpecker. Blythipicus pyrrhotis pyrrhotis.**

All our hills.

461. **Northern Rufous Woodpecker. Micropternus brachyurus phaioceps.**

This woodpecker excavates holes in ants' nests for its nest. *Phaioceps* is the subspecies of Burma.

462. **The Burmese Golden-backed Three-toed Woodpecker. Dinopicus javanensis intermedia.**

All these Burma Hills. I see a note of young bird observed in the middle of April in the Shan States. This nest was about 5 ft. off the ground, but in a big trunk quite 2 ft. in diameter.

463. **The Himalayan Golden-backed Three-toed Woodpecker. Dinopicus shorii.**

Chin Hills, and probably West Kachin Hills.

464. **Tickell's Golden-backed Woodpecker. Chrysocolaptes guttacristatus guttacristatus.**

A common woodpecker of all these hills.

465. **The Indian Great Slaty Woodpecker. Mulleripicus pulverulentus harterti.**

Not a common bird by any means in our hills. I can record it in the Shan Hills.

466. **The Burmese Great Black Woodpecker. Thriponax javanensis feddeni.**

Kachin Hills (Harington). It occurred in the Shan Hills in suitable jungle sparingly. I never found the nest, but the *Fauna* records Cook taking them at Maymyo, 40 miles east of Mandalay, early in Februry. I cannot recognize the place where Grant is stated in the *Fauna* to have taken another nest.

467. **The Malay Speckled Piculet. Picumnus innominatus malayorum.**

Harington records this bird in the Kachin Hills and the *Fauna* says the Southern Shan States; so presumably it might be found anywhere in these hills.

468. **The Rufous Piculet. Sasia ochracea ochracea.**

In the Kachin Hills.

469. **Cachar Rufous Piculet. Sasia ochracea querulivox.**

In the Chin Hills.

470. **The Burmese Rufous Piculet. Sasia ochracea reichenowi.**

Probably in the Shan Hills.

471. **The Japanese Wryneck. Iynx torquilla japonica.**

Winter visitor to our hills. Have caught it more than once in the house probably coming in after insects and not being able to find its way out.

XXXIV.—Family CAPITONIDÆ

472. The Great Chinese Barbet. Megalaima virens virens.

In the Shan States and probably the Kachin Hills.

473. The Assam Great Barbet. Megalaima virens magnifica.

In the Chin Hills. A nest I found in the Shan Hills had not been excavated by the bird, normally an early breeder and fairly common all over the Burma Hills.

474. The Assam Lineated Barbet. Thereiceryx lineatus hodgsoni.

In the Chin Hills and N. Burma.

475. The Burmese Lineated Barbet. Thereiceryx lineatus intermedius.

The Burmese subspecies in the Shan Hills south. 'Po Toke' is one of the Burmese names for this bird resembling the call. It nests, like all barbets, in rotten trees. In the plains I took the nest at the end of February, and in the hills at beginning of May, but I do not think that this substantiates a claim that the plain birds breed earlier than the Hill ones.

476. The Blue-throated Barbet. Cyanops asiatica asiatica.

477. Davison's Blue-throated Barbet. Cyanops asiatica davisoni.

The subspecies *asiatica* in the North and Western Hills, and *davisoni* in the S. Eastern Hills. Probably the subspecies are a bit mixed in the middle of the Shan States, anyway there seems to be a mistake in the *Fauna* in the description of the band across the vertex of *davisoni*. Nests end of April.

478. The Indian Blue-eared Barbet. Cyanops duvaucelli cyanotis.

Seems to have been missed by Mackenzie, Harington and even Rippon although it probably occurs in North Burma.

479. The Thick-billed Barbet. Cyanops robustirostris.

May also occur in our Northern Hills.

480. The Golden-throated Barbet. Cyanops franklinii franklinii.

481. Ramsay's Golden-throated Barbet. Cyanops franklini ramsayi.

Both appear to inhabit our hills, the latter in the South Shan Hills. Harington records this species as plentiful in the Kachin Hills, and Mackenzie took eggs in the North Chin Hills; early May. Robinson obtained eggs of *ramsayi* in South Shan Hills; end of April.

482. The Burmese Crimson-breasted Barbet. Xantholæma hæmacephala indica.

The *Fauna* the description of the subspecies *X. h. hæmacephala*, if it occurs in India, is omitted. In the key *indica* has a culmen 15 mm. or under, while in the description under the species the length of the culmen is recorded 17 to 18 mm. No doubt the mistake if any will be corrected.

Occurs in all our hills, an early breeder generally. I found nests in thin rotten branches of trees, often so thin you would think a bird could hardly turn round in the hole. Quite common enough in Burma I may add!

All Barbets seem to take some time to make their nest cavities.

XXXV.—Family CUCULIDÆ

483. The Khasia Hills Cuckoo. Cuculus canorus bakeri.

The cuckoo of Burma. Begins to call the second week in March but does not seem to lay till the end of April. The eggs taken by me in the Shan Hills are nearly all of one colour rather like '*Suya*', but I have also taken blue eggs, and although I have frequently taken them from *Anthus r. rufulus*, the eggs were always of the same type. Hopwood found this cuckoo's egg in nest of *M. palustris* but *Saxicola caprata* seemed the most favoured foster parents.

484. The Himalayan Cuckoo. Cuculus optatus.

I think I obtained the egg of this bird in a nest of *Phylloscopus* in the Chin Hills. Mackenzie records its finding in nests of *A. davisoni*.

485. The Small Cuckoo. Cuculus poliocephalus poliocephalus.

Probably occurs in the Northern Hills.

486. The Indian Cuckoo. Cuculus micropterus micropterus.

The 'Youkhpa, Quay, Kor' of the Burmese. I took an egg out of a nest of *S. caprata* in the Shan Hills, where this cuckoo is however rather uncommon, especially compared to the Chin Hills and the plains of Burma. The egg was blue with reddish spots which I have always considered the egg of this bird.

487. The Large Hawk-Cuckoo. Hierococcyx sparveroides.

In the Shan Hills I took an egg of this bird, I believe, from a nest of *Garrulax l. belangeri*; middle of May: Hopwood and Mackenzie obtained several in the N. Chin Hills, *P. maclellandi* being the commonest fosterer. Mackenzie also records the finding of the eggs.

488. The Common Hawk-Cuckoo. Hierococcyx varius.

Eggs were taken by Mackenzie on two occasions in the North Chin Hills. The fosterers were *Ianthocincla cineracea*.

489. Hodgson's Hawk-Cuckoo. Hierococcyx fugax nisicolor.

Recorded from the Chin and Shan Hills and it must also occur in the Kachin Hills.

490. The Burmese Plaintive Cuckoo. Cacomantis merulinus querulus.

A very common Burma bird but I do not remember it in the Chin Hills. In the Shan Hills it was found laying in nests of *Franklinia* and *Cisticola*. May and early June.

491. The Indian Banded Bay Cuckoo. Penthoceryx sonneratii sonneratii.

Occurs in Burma but has been recorded by no one lately.

492. The Violet Cuckoo. Chalcites xanthorhynchus.

I have an egg from a nest of *Franklinia* which must belong to either this or the next species.

493. The Emerald Cuckoo. Chalcites maculatus maculatus.

Taken in the Shan Hills. Harington records the latter bird in the Kachin Hills.

494. The Indian Drongo Cuckoo. Surniculus lugubris dicruroides.

Except the recording of it in all these hills little seems to be known of its nidification, although Mackenzie considered he found an egg in a drongo's nest in the N. Chin Hills. I remember shooting a fully-fledged, young bird near Rangoon. The call is easily recognizable when once heard.

495. The Pied Crested Cuckoo. Clamator jacobinus jacobinus.

Occurring in all these hills, but in my opinion very few in numbers compared to the plains.

496. The Red-winged Crested Cuckoo. Clamator coromandus.

Common in all our hills. The eggs have been frequently taken. I have a clutch of 5 with 4 of *G. moniliger* the foster birds, taken at Maymyo, east of Mandalay in the Shan Hills. The bird seems a more frequent night caller than other cuckoos and it has a call different to its usual harsh screaming.

497. The Malay Koel. Eudynamis scolopaceus malayana.

Found in all three hills.

498. **The Large Himalayan Green-billed Malkoha. Rhopodytes tristis.**

A fairly common bird in all these hills, especially the Shan Hills, where at about 3,000 ft. elevation it thrives and nests and in any beat for jungle fowl, this bird is sure to appear.

I notice the subspecies *longicaudatus* is mentioned in the *Fauna* as occurring in the Southern Shan Hills, but I have never had the opportunity of examining skins.

499. **Hume's Crow Pheasant. Centropus sinensis intermedius.**

Our Burma hill bird is presumably the subspecies *intermedius*. It differs from the Indian bird in size only, the Burmese bird being a little smaller all over except its length of tail.

500. **The Lesser Coucal or Crow Pheasant. Centropus bengalensis bengalensis.**

In our hills, it appears to be an inhabitant mostly of the long thatch grass wherein it nests. It seems, if possible, a more feeble flier than its larger brother. I agree 3,000 ft. in the hills is its usual elevation. A rains breeder.

XXXVI.—Family PSITTACIDÆ

501. **The Large Burmese Paroquet. Psittacula eupatria indoburmanica.**

Must be included in our hill birds, but it keeps to very low elevations as does.

502. **The Eastern Rose-ringed Paroquet. Psittacula krameri borealis.**

503. **The Eastern Blossom-headed Paroquet. Psittacula cyanocephala bengalensis.**

I cannot say whether this bird occurs in the eastern hills, i.e. the Chin Hills of Burma. I found it breeding in the Shan Hills early in March and actually shot a nesting bird. Elevation 3,000 ft. Harington records its occurrence in the Kachin Hills.

504. **The Burmese Slaty-headed Paroquet. Psittacula schisticeps finschi.**

Recorded by Mackenzie in the N. Chin Hills and in the Southern Shan Hills (Kalaw) by Cooke, it also occurs, I believe, near Maymyo further north in these hills and probably in the Kachin Hills also.

505. **The Indian Red-breasted Paroquet. Psittacula alexandri fasciatus.**

Not so common in these hills as one would expect as it is common enough in the plains of Burma.

506. **The Indian Loriquet. Coryllis vernalis vernalis.**

One seldom sees this little bird in the hills of Burma, at least I have personally found it rare and it is only on occasions that one recognizes its familiar call when flying swiftly overhead. In the Andamans one found them breeding very early; young birds in January, but I have no experience of their breeding in these hills.

XXXVII.—Family CORACIIDÆ

507. **The Burmese Roller. Coracias bengalensis affinis.**

My experience is that this Burmese subspecies breeds at end of March and beginning of April all over Burma, often, if undisturbed using the same tree-hollow—year after year. The wonderful flight contortions of this bird are truly recorded.

508. **The Broad-billed Roller. Eurystomus orientalis orientalis.**

Occurring over all our hills in the jungle; it is not difficult to find the nesting place but extremely difficult to rob it as it chooses as a rule a hollow at a considerable height up in a large forest tree.

XXXVIII.—Family Meropidæ

509. The Burmese Green Bee-eater. *Merops orientalis birmanus.*

A common bird in our hills ; the Telegraph lines seem its normal habitat !

510. The Blue-tailed Bee-eater. *Merops superciliosus javanicus.*

Also fairly common in places and seems to have a preference for river valleys. A breeding colony is a sight worth seeing.

511. The Chestnut-headed Bee-eater. *Melittophagus erythrocephalus erythrocephalus.*

Fairly common throughout our hills, it seems much more solitary in its habits than the other bee-eaters and certainly does not breed in colonies.

512. The Blue-bearded Bee-eater. *Bucia athertoni.*

Occurs throughout our hills and is particularly common in the Shan Hills at the beginning of the rains which made me consider it was locally migratory. Nest holes I have seen were only just above the ground level and, considering how shy the birds are, sometimes in quite exposed situations–roadside drains and banks. I quite agree with the *Fauna* as to the difficulty of securing the eggs as I have opened a good many nest holes without ever obtaining them.

XXXIX.—Family Alcedinidæ

513. The Indian Pied Kingfisher. *Ceryle rudis leucomelanura.*

The bird may be found in the foothills and in the Shan Hills up to about 3,000 ft. where the river valleys are wide; one does not come across it frequenting the hill streams proper, it likes 'open' rivers, canals and lakes. The champion 'hoverer' of its tribe and one wishes the brilliant blue kingfisher would copy this habit to the same extent and in the same confiding manner ; nests in Burma in winter months, as recorded.

514. The Himalayan Pied Kingfisher. *Ceryle lugubris guttulata.*

Common in the Chin Hills and recorded from the Kachin Hills. I cannot remember it in the Shan Hills but it probably occurs as it is found in Yunnan ; it is curiously shy for a kingfisher and liable to escape notice.

515. The Common Indian Kingfisher. *Alcedo athis bengalensis.*

Common in all our hills.

516. The Malay Blue-eared Kingfisher. *Alcedo meningting coltarti.*

Recorded as occurring in Burma, but I knew it not in these hills.

517. Blyth's Kingfisher. *Alcedo hercules.*

Recorded in the Chin Hills according to the *Fauna*.

518. The Broad-zoned Kingfisher. *Alcedo euryzona.*

I can record this bird from 40 miles north of Taunggyi in the Shan Hills. Rare and shy, but I once had it perched within a few feet of me, on the banks of a jungle stream far from man's abode.

519. The Indian Three-toed Kingfisher. *Ceyx tridactylus tridactylus.*

Occurs throughout the Burma Hills. One killed itself against the Civil Hospital Operating Room window at Maymyo, some 40 miles east of Mandalay, in the Shan Hills. Nowhere common.

520. The Burmese Stork-billed Kingfisher. *Ramphalcyon capensis burmanica.*

Inhabits all our hills. I found it nesting in the bank of a perennial stream in the Shan Hills at about 3,000 ft., end of April ; 4 eggs fresh, the entrance to the nest was large and the egg chamber only a little way in.

521. The Indian White-breasted Kingfisher. *Halcyon smyrnensis fusca.*

Common everywhere in the hills and a great lover of a hill roadside bank to nest in. In Burma it is the commonest kingfisher.

522. **The Black-capped Kingfisher. Halcyon pileata.**

An inhabitant of the eastern hills being often met with in the Shan Hills up to the very eastern extremity. It probably also occurs in the Kachin Hills and, as it is found in Assam, probably also in the Chin Hills though I cannot recall seeing it there. My idea is that it is more numerous inland and up the hill streams in the breeding season. In April I found it quite common on an eastern tributary of the Salween River in the Shan Hills evidently breeding or about to breed. I never took a nest however.

XL.—Family BUCEROTIDÆ

523. **The Great Hornbill. Dichoceros bicornis bicornis.**

More common in the Chin Hills than the Kachin and Shan Hills. I attributed the death of a tame bird I had, to its being given meat. This bird would have made a fine 'slip' at cricket as it caught anything within reach. I never tried throwing anything but fruit at it and the catch was made with the end of the bill and then tossed up and caught in the back of the throat when it could be swallowed.

524. **The large Indian Pied Hornbill. Anthraceros malabaricus malabaricus.**

525. **The Burmese Pied Hornbill. Anthraceros malabaricus leucogaster.**

Both these subspecies inhabit the Burmese Hills probably the latter in the Southern Shan Hills only. I took fresh eggs on the 16th March in Tennasserim. Probably they breed in the hills about the same time. The Pied Hornbill is a very common bird in the Shan Hills, but the nest is difficult to locate.

526. **The Malayan Wreathed Hornbill. Rhyticeros undulatus.**

A large hornbill which occurs somewhat sparingly in all these Burma Hills.

527. **Blyth's Wreathed Hornbill. Rhyticeros subruficollis.**

The swish caused by hornbills descending from high up in the air to their nesting tree is a noise worth hearing. I found a nest of this species solely by hearing this noise. Burmese name 'Goryin'.

528. **The Rufous-necked Hornbill. Aceros nepalensis.**

Recorded in the *Fauna* as occurring in the Chin and Kachin Hills.

XLI.—Family UPUPIDÆ

529. **The Burmese Hoopoe. Upupa epops longirostris.**

A familiar and attractive bird in all hill stations as well as the plains. Nests beginning of April, but I have taken eggs in June although I should not say it normally had two broods.

XLII.—Family TROGONIDÆ

530. **The Red-headed Trogon. Pyrotrogon erythrochphalus erythrocephalus.**

Inhabits all these hills and is not uncommon where there is suitable heavy jungle and often seen when beating for jungle fowl.

531. **Robinson's Yellow-breasted Trogon. Pyrotrogon oreskios uniformis.**

This bird extends very much further north than Tenasserim. I have myself seen it on the west coast of Burma. Hopwood also records it from Arakan. A friend described this bird to me in the Kachin Country; so it probably spreads up, sparingly, throughout Burma. The upright attitude of this bird when perching is very marked: one has the idea too that this bird is more sluggish in the day-time than the Red-headed Trogon.

XLIII.—Family MICROPIDÆ

532. **The Large White-rumped Swift. Micropus pacificus pacificus.**

533. **The Burmese White-rumped Swift. Micropus pacificus cooki.**

The two subspecies *pacificus* and *cooki* occur in our hills, the latter recorded from the Shan Hills where its breeding was the subject of a note in

the *Journal* by Col. Harington (*Journ. B.N.H.S.*, vol xxiii, p. 155). I paid a visit to that nesting site, the Gokteik Gorge, on March, 17, 1924 and there was not a swift of this species there. The roof of the cave was occupied by a small swift probably of the genus, *Collocalia.*

534. **The Malay House-Swift. Micropus affinis subfurcatus.**

Occupies hills and plains alike all over Burma. Have taken the eggs out of nests in buildings and caves but have never seen a big colony of them. May to July seem the breeding months.

535. **The Eastern Palm-Swift. Tachornis batasiensis infumatus.**

Chin Hills where it copies the Assam birds and breeds in the thatch of Hill-tribe houses. I have also taken its nest under palm leaves. Harington remarks that nearly every Kachin house has a few nests in the eaves. In the ShanHills, as similar thatched buildings do not exist, it breeds in the palm trees.

536. **The Brown-throated Spine-tail. Hirundapus giganteus indicus.**

I knew this bird in the Andamans, but I have never noted it in our hills. Mackenzie thought he saw a flock in the North Chin Hills and I expect he was correct. The pace of their flight is wonderful.

537. **The Himalayan Swiftlet. Collocalia fuciphaga brevirostris.**

Presuming my identification is correct, I noted this bird as breeding in many of the caves in limestone rocks in the Shan Hills in March. In the Gokteik Gorge Cave, which forms a natural bridge over a river in the Shan Hills not far from Maymyo and on which a high railway bridge has been constructed, the birds' nests could not be seen as they were in the natural hollows of the cave itself; these hollows are probably big, but the entrance to them from the cave is small and the nesting place must be practically in darkness. I noticed many birds going into the same entrance. There were no broken egg shells upon the ground.

538. **Indian Crested Swift. Hemiprocne coronata.**

To be seen in all our hills haunting generally the jungle clearings for cultivation where some trees have not been felled but which are dead. These trees or rather the branches of them are used as nesting sites. I have heard them making a call when in flight very similar to the call of the small Woodpecker, *Dryobates.*

XLIV.—Family Caprimulgidæ

539. **The Burmese Long-tailed Nightjar. Caprimulgus macrourus bimaculatus.**

This is the commonest Nightjar in the Shan Hills and has also been recorded from the Chin and Kachin Hills. I have heard this species calling quite early in the afternoon.

540. **The Japanese Jungle Nightjar. Caprimulgus indicus jotaka.**

Two white ground eggs taken for me in the Chin Hills, Mt. Victoria, must have belonged to this bird as Mackenzie took it in the North Chin Hills.

541. **Franklin's Nightjar. Caprimulgus monticolus monticolus.**

Recorded as occurring throughout Burma in the *Fauna*, but latter day ornithologists in the country seem to have missed it as neither Harington, Mackenzie or anyone else, that I can find, record it.

542. **The Common Indian Nightjar. Caprimulgus asiaticus.**

Recorded by Mackenzie in the North Chin Hills, probably in the plains adjoining.

543. **The Burmese Great Eared Nightjar. Lyncornis cerviniceps.**

Chin Hills, at any rate but if it occurs in the eastern hills, it is rare I should think.

XLV.—Family PODARGIDÆ

544. Hodgson's Frogmouth. Batrachostomus javanensis hodgsoni.

The nests of this bird were taken by Mackenzie in the North Chin Hills. I regret I have never come across it. It appears to miss the eastern hills.

XLVI.—Family TYTONIDÆ

545. The Indian Barn Owl. Tyto alba javanica.

Inhabits all these hills.

546. The Grass Owl. Tyto longimembris.

This bird is to be found in suitable places throughout the Shan Hills. It requires open grass spaces. Nests on the ground in the cold weather. The nests I have seen are very scanty grass affairs, in fact, look as if they were simply made of some of the surrounding grass trodden down, with a feather or two included. One nesting place was well hidden by overhanging grass, but one from which I obtained eggs was quite open. I examined the pellets of this bird and found them made up of mice remains, but one contained a skull and beak—the upper mandible of a Quail (*Turnix*).

In the daytime when disturbed they do not fly far and soon flop down in the grass again, but at night, as may be expected, they are quick, silent hunters. I have seen them behaving as if they were catching insects of some sort like large white bats.

I do not think the bird occurs in the Chin Hills and there is no record of it in the Kachin Hills that I can find.

XLVII.—Family ASIONIDÆ

547. The Bay Owl. Phodilus badius badius.

Probably Shan Hills and Eastern Kachin Hills.

548. The Himalayan Wood-Owl. Strix nivicola.

Shan Hills.

549. The Himalayan Brown Wood-Owl. Strix indranee newarensis.

I should think this is the subspecies of the Shan Hills.

550. The Bengal Brown Fish-Owl. Ketupa zeylonensis leschenaulti.

Recorded from the Chin and may occur in the Kachin and Shan Countries.

551. The Indian Great Horned-Owl. Bubo bubo bengalensis.

552. The Forest Eagle Owl. Huhua nipalensis.

May probably both be obtained in our hills. I have heard the latter in the Chin Hills.

553. The Burmese Collared Scops Owl. Otus bakkamœna lettia.

A common bird in all these hills. In the Shan Hills I notice my nests were generally taken the last week in March. In one case the hollow used was within easy reach, in another an old woodpecker's nest much higher up had been used.

554. The Eastern Spotted Scops Owl. Otus spilocephalus spilocephalus.

Recorded from Kachin Country and Shan Hills.

555. The Burmese Scops Owl. Otus sunia modestus.

Shan Hills, according to the *Fauna*.

556. The Burmese Spotted Owlet. Athene brama pulchra.

Not nearly so common in the hills as in the plains. So noisy that one would think it was about the most quarrelsome bird in the country.

557. **The Burmese Barred Owlet. Glaucidium cuculoides rufescens.**

Occurs in all these hills.

558. **The Jungle Owlet. Glaucidium radiatum radiatum.**

Recorded by Mackenmie in the Chin Hills.

559. **The Eastern Collared Pigmy Owlet. Glaucidium brodiei tubiger.**

Harington records this little owl as being plentiful in the Kachin Hills and I have seen it in the Shan Hills ; it also probably occurs in the Chin Hills.

560. **The Burmese Brown Hawk-Owl. Ninox scutulata burmanica.**

Chin, Kachin and Shan Hills : in the latter I often came across this bird when beating patches of jungle for woodcock and their flight is something similar to that bird.

(*To be continued.*)

THE PANTHERS AND OUNCES OF ASIA

BY

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(*With Plates I-VI*)

Introduction

In this paper on the Panthers or Leopards of Asia I have followed the same lines as those adopted in my paper upon Tigers (*Journ. Bombay Nat. Hist. Soc.* xxxiii, No. 3, pp. 505-41, 1929).

The terms 'panther' and 'leopard' are used somewhat indiscriminately and inconsistently as synonyms. Leopard is the name by which the animal is commonly known amongst English-speaking people in Europe, America and Africa; but I have given preference to the term panther because I have been told it is more usually employed by Indian sportsmen.

In the tables of skull-measurements the same dimensions have been taken as in the case of the tigers, with the omission of the occiput. The *total length* is taken from the tip of the occipital crest to the tip of the premaxillæ; the *condylo-basal length* (*Cond. bas.*) from the edge of the occipital condyle to the same point above the upper incisors; the *zygomatic width* (*Zygom.*) is across the cheek bones; of the *nasals* the length from the middle line behind to the tip of the processes bounding the nostrils and the width across these processes are given. In the case of the *teeth,* the total length of the upper and lower flesh-teeth (*upper* and *lower carnal.*) and the width of the canine from back to front close to the socket (*upper canine*) are recorded.

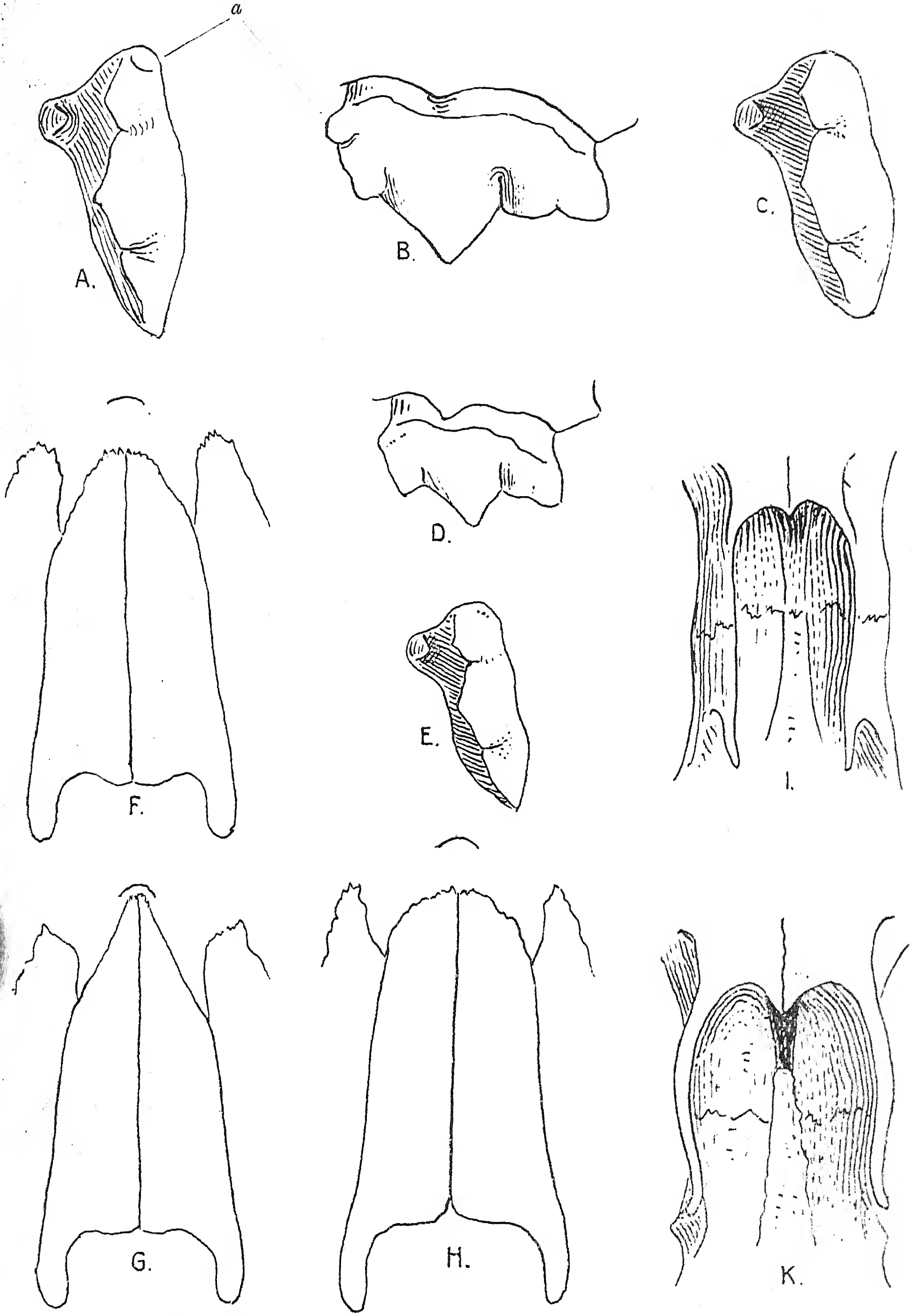
It is the custom amongst zoologists to record all measurements of skulls, and even of skins, by the metric system. But in deference to Indian sportsmen and naturalists for whom the paper is mainly written I have used English inches for the skins and skulls as in the paper on Tigers, the only change being the substitution of decimal for vulgar fractions. For the teeth, however, millimetres, of which twenty-five go to the English inch, have been employed as more suitable for small structures.

My remarks regarding the inadequacy of specimens of skins and skulls of tigers apply equally to panthers and need not be repeated.

The Kinship between Panthers and Tigers

(Pl. I)

In the paper on Tigers, above referred to, I gave reasons for separating the lion, tiger, panther and jaguar from the rest of the Felidæ under the name *Panthera,* of which the panther is the typical



A, B. Upper carnassial tooth, with anterior tubercle (*a*) of Tiger from Nepal.
C. The same, without tubercle, of Tiger from the Central Provinces.
D, E. The same of Panther from Kashmir.
F, G, H. Nasal bones of Panthers from Daltonganj, Pekin and Annam.
I, K. Mesopterygoid fossa of Panthers from Dharwar and Kashmir.

(All figures natural size.)

species or geno-type; and in refutation of the claim upheld by some modern authors that the differences between the lion and the tiger justify their ascription to distinct genera, named *Leo* and *Tigris* respectively, I insisted upon the tolerably close affinity between them and showed that many of their alleged differences in cranial characters have no foundation in fact, being much too variable to be diagnostic.

It now remains to be seen if there are any good reasons for regarding the tiger and panther as different genera, a view held by the Russian zoologist, Satunin, (*Mitth. Kauk. Mus.* IV, pp. 24-5, 1909), who enumerated three distinguishing characters in the skull, as follows :— (1) In the tiger the nasal bones considerably overlap the summit of the maxillæ; in the panther the summits of the four bones are approximately on a level. (2) In the tiger the infraorbital foramen, the hole on the cheek just below the eye, is oval; in the panther it is circular. (3) In the tiger the upper carnassial tooth has a small supplementary cusp on the front of its outer edge, its antero-external angle; in the panther's upper carnassial this cusp is absent.

I will take these characters in order and show that not one of them holds good. (1) In my paper on Tigers I pointed out that, although as a rule, in this species, the nasal bones considerably overlap the maxillæ, they do not always do so, sometimes only exceeding them very slightly, as in the skull of a tigress from Mergui, or indeed not at all as in the skull of a tiger from Sumatra. The bones also vary in panthers, although as a rule they are approximately equal. For instance, the nasals fall slightly short of the maxillæ in a female skull from Daltonganj in Bengal and in one from Annam; but markedly exceed them in a skull from Pekin and are a little longer in all the Javan skulls I have seen (Pl. I, figs. F, G, H). Finally, it may be added that de Blainville (*Osteogr.* atlas II, Pl. VIII, 1839-64), figured the skulls of a male and female panther from Barbary in both of which the nasals pass beyond the maxillæ. They only do so to a comparatively small extent in the male; but in the female they surpass them perhaps quite as much as in typical tigers. (2) Examination of a series of skulls of tigers and panthers shows that the shape of the infra-orbital foramen is much too variable in both species for it to be used as a distinguishing feature. (3) The supplementary antero-external cusp on the upper carnassial in tigers may be conspicuously present, indistinctly defined or entirely absent. On Pl. I, figs. A, B, C, I give drawings of this tooth in the skulls of tigers from Nepal, with the cusp tolerably well developed, and from the Central Provinces in which there is no trace of it. Its incidence is curious. Usually it is present and larger or smaller as the case may be; but in several skulls from Central India it is obsolete, as it is in the typical skull of the Chinese race and also in the Javan race. In the Caucasian and Persian race it is as large as in any; and no doubt Satunin drew his conclusion regarding it solely from Caucasian material. In adult panthers it may be described as absent (Pl. I, figs. D, E), although a vestige of it is not uncommonly just detectable by touch if not by sight; but in the unworn, newly erupted

tooth it is frequently at all events present. But clearly its variability in tigers alone excludes it even as a specific character between these animals and panthers.

One or two additional cranial differences alleged to exist must also be dismissed. Blanford, who quite correctly, in my opinion, assigned tigers and panthers to the same genus, stated, for instance, that in the tiger the lower surface of the mandible is nearly straight to near the posterior angle, then slightly concave, so that the skull, with the lower jaw attached, rests firmly on a flat surface, whilst the posterior portion of the skull nowhere touches that surface. In the panther, on the contrary, he adds, the lower jaw is convex beneath and the skull, when placed on a flat surface with the mandible attached, almost always rests with its hinder portion on that surface. This last character was recently cited by Mr. Prater in corroboration of his view that the skull of a tiger shot by Mr. Limouzin near Ootacamund was a big panther's. But, as I pointed out in my paper, the back of the skull in tigers frequently rests on a flat surface. In adult male skulls it is elevated, but in skulls of young males and tigresses the occiput is often in contact with the surface. So, too, in panthers' skulls. In adult male skulls the occiput is generally raised to a slight extent. In the skull of an oldish male from Kashmir it is raised, indeed, almost half an inch. In females and young males, on the contrary, the condyles or mastoids of the occiput touch the surface. In the case of the mandible, the general straightness of the lower edge is tolerably constant in tigers; but the shape of this edge is very variable in panthers. Sometimes it is convex in the middle with the chin raised, so that the skull 'rocks' as in lions; at other times the chin and the posterior angles are alike in contact with the surface, so that the skull rests as steadily as in tigers. These variations depend upon the effects on the skull of the development of the jaw-muscles and are mainly matters of age and sex.

The cranial differences, indeed, between the two animals are comparatively slight and merely of specific value, the panther's skull being smaller and having smaller teeth. The differences in size are very marked when the skulls of male tigers are compared with those of male panthers and of tigresses with female panthers; but the skulls of the biggest male Indian panthers are almost as big as those of the tigresses from the Sunda Islands. And the same applies to bodily size. The differences in pattern and voice are well-known; and panthers never appear to grow the fringes on the cheeks possessed by most tigers. They also have longer tails and appear to be relatively longer in the body and lower on the leg, differences which are no doubt correlated with arboreal habits.

The identity between Panthers and Leopards

Literature relating to this animal contains much controversial matter, dating from the days of Buffon, Cuvier and Temminck, regarding the existence of two distinct types described as Le Panthère (*Felis pardus*) and Le Léopard (*Felis leopardus*), the panther and the leopard of English writers. But there was much

disagreement as to the characters of the two owing in a measure to conclusions being drawn from different data supplied by skins or living animals or even skulls from various countries. Some relied upon the size of the spots or the length of the tail and general build, and Temminck thought he had discovered an important and constant difference in the shape and dimensions of the skull; but in support of his contention he figured the skulls of a male and female of the Javan race as representing respectively Le Léopard and Le Panthère.

It would be waste of time and space to attempt to epitomise the diverse opinions on this point with reference to the leopards of Africa and Asia which the authors of the early part of the nineteenth century discussed, since all modern zoologists are agreed that it is not a question now of two kinds of leopards inhabiting those continents but of several; and discussion has shifted to a decision as to how many there are and what their correct names may be.

But in India, it appears, the two terms, panther and leopard, are still in use. From conversations with sportsmen, I have, however, been quite unable to discover any unanimity in their application. None now believes, as Sykes believed a century ago (*Proc. Zool. Soc.*, 1830, p. 102), that two distinct species exist in India; but many, I suspect, employ the terms in a general way as Jerdon employed them in 1867 (*Mammals of India,* p. 97) in his non-committal summary of the views of Blyth, Walter Elliot and others. The upshot of his remarks is that there is a larger, paler, more boldly spotted, closer coated variety, the panther, which is seldom found in dense forest but occurs in the ravines of rocky hills and more open country generally, and a smaller, darker, less boldly spotted, fuller coated variety, the leopard, which is found in forested districts.

There is no doubt that some Indian writers of long ago confused the two sexes, as Temminck did, because we find one of the diagnostic features of the panther to be the cranial characters of the male; but Jerdon's opinion no doubt was that the two varieties are environmental races. My own opinion on the matter, based on the material I have seen, is this. When, if it ever comes about, panthers or leopards are collected on the scale on which squirrels, mice, shrews and other animals have been collected by the Mammal Survey of India, with accurate records of dates, localities and habitats, it will be found that, not two only, but several local or environmental races occur in British India. At the present time there is sufficient material in the way of skins to suggest the truth of this opinion; but a hopelessly insufficient amount to establish or refute it. And the question will remain unsettled so long as sportsmen's interests in panthers are restricted to shooting them as dog-eaters, to keeping their skins as rugs, or to adding an inch to their recorded dimensions.

The Distribution of Panthers

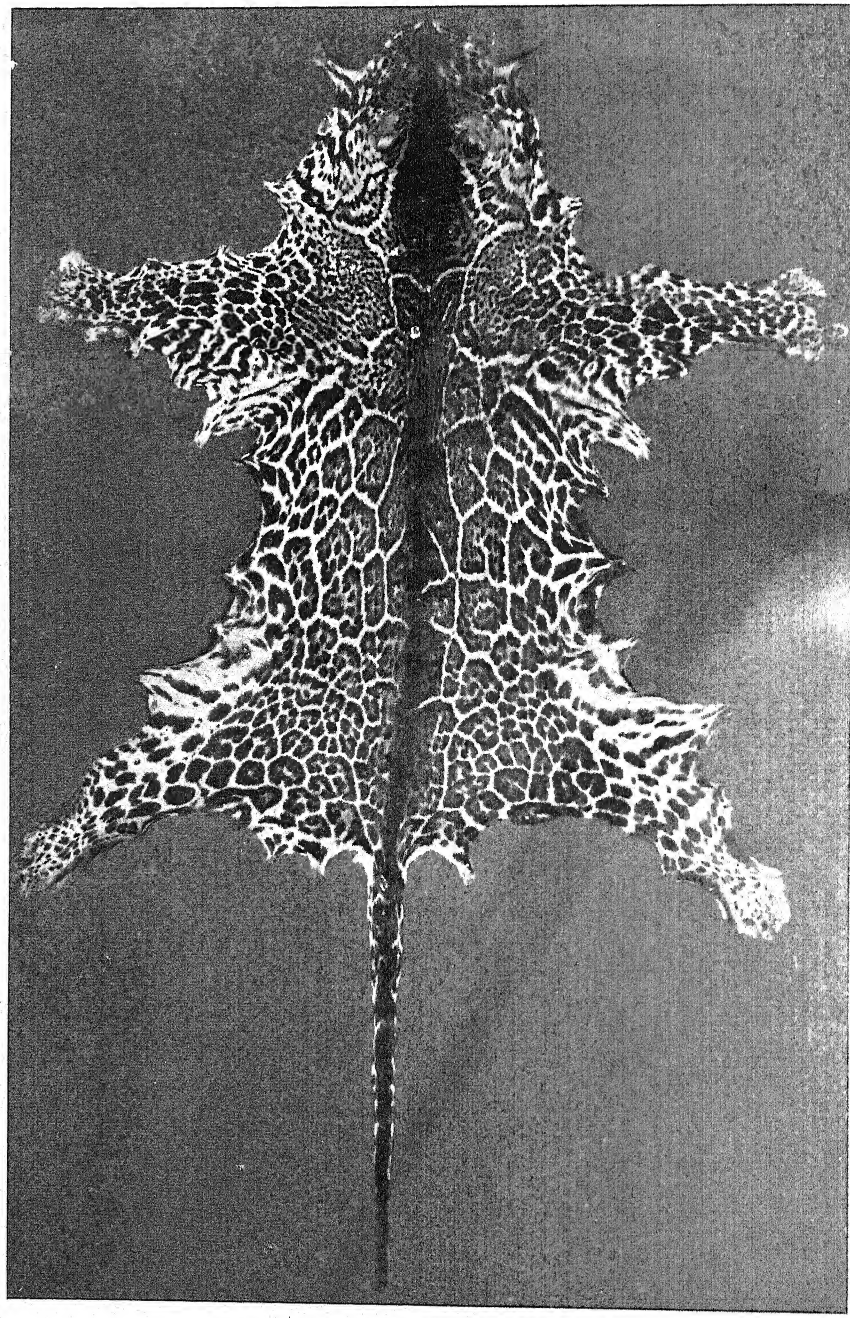
The distribution of panthers, or leopards, coinciding, as it does, with those of lions and tigers combined, and in places overlapping them, has many points of interest. Fossil remains have been found

in Central and Southern Europe; and from the close kinship between the panther of the old world and the jaguar of the new, it may be inferred that the common ancestor of the two lived at one time sufficiently far to the north to pass to N. America, when it was joined to Asia, by the route taken by wolves, foxes, wapitis, and other animals common to the two continents. In north-eastern Asia they survive at the present time in Manchuria and Korea and, it is alleged, in Amurland and Saghalien; but there are none, and probably never were any, in Japan. Extending throughout China they pass through Burma into the Malay Peninsula and thence into Java but not into Bali to the east of it. Their existence in Sumatra, whence they have been recorded, has been recently called in question. Their range, indeed, in the Sunda Islands suggests that they were later comers to that part of Asia than tigers which are plentiful in Sumatra and Bali. On the other hand their presence in Ceylon, where tigers are not found, points to their occupation of peninsular India at an earlier date than tigers. Perhaps they invaded India by two routes, south of the eastern and of the western ends of the Himalayas respectively. At all events they are found in Baluchistan, on the Persian Gulf and all over Asia Minor, everywhere overlapping the tiger in south-western Asia and even passing into Europe north of the Caucasus by the Aral Sea. Since they accompanied the lion and the hunting leopard into Africa, they may equally well have accompanied them, or even preceded them, into India from the west. But their occurrence alongside tigers in China, Burma and along the southern slopes of the Himalayas is equally suggestive of their entry into India by the eastern route as well.

Variations in Colour and Pattern of Panthers

(Pls. II and III)

The ground-colour of panthers varies normally to a slight extent individually in the same locality and very considerably in different habitats; that is to say, from grey in Seistan and Persia to almost rusty brown in Java. Of abnormal types of coloration black is the commonest. This phase arises from the invasion of the normally yellowish hairs by black or blackish-brown pigment, called melanin. But the intensity of the tint of this pigment is variable. Sometimes it is as deep as the black of the spots which can then only be seen under reflected light by reason of their superior sheen. But quite commonly on the belly it is dark brown so that the spots show up clearly on this area. Black panthers of this type are particularly plentiful in Java and the southern parts of the Malay peninsula. Northwards they have been recorded from Burma, the Shan States, Assam and Nepal and they are alleged to be not uncommon in Travancore and other parts of Southern India. Knox, indeed, referred to a Ceylonese specimen as 'a black tiger'. In the Central Provinces they are comparatively rare; but Dunbar Brander mentions one he saw at Melghat in 1913 which was of exceptional interest, the ground colour being dark chestnut and the spots



Variety of Indian Panther from Cuddapah.

distinctly visible. This specimen was apparently intermediate in tint between a typical black leopard and a normally coloured individual. In that respect it was, I believe, unique, for, as a rule, in Asiatic leopards melanism is a discontinuous variation, that is to say, the animal is either a definite melano or normally coloured and cubs of both types may occur in the same litter.

In Africa, so far as I am aware, black leopards of the kind described above are almost unknown, except in Abyssinia. But in that country the variation is not discontinuous, every intermediate stage between blackening of the spinal area alone to its extension all over the body and limbs being known.

Panthers also exhibit, but much less commonly, the opposite phenomenon, namely, failure to develop pigment which in extreme cases results in albinism. In the British Museum there are a few skins which may be described as semi-albino. One is a reddish skin from Hankow, presented by Mr. Poland, in which the pattern is very indistinct owing to its assimilation in tint to the ground colour. In another from Hazaribagh, presented by R. E. S. Thomas, the ground colour is paler than usual and the spots are tan. In a third from Rhodesia, presented by Dr. Walter Fisher, the spots are sepia or pale chocolate brown and the interspaces sandy. I have only seen one white leopard skin. This is in Mr. Poland's collection and is believed to have come from East Africa. Both the spots and the interspaces are colourless, the spots being visible only under reflected light. This animal was probably a pure albino with blue or pink eyes.

In the variations of colour above described panthers are very similar to tigers. But there is this curious difference. Black leopards are tolerably common; black tigers are very rare. Conversely, albino or semi-albino leopards are rare; but albino or semi-albino tigers are not so very uncommon at least in certain districts of India. There is, on the other hand, a very great difference between the two species in variation affecting the pattern. Tigers vary in the number, width, depth of tint and looping of their stripes. Leopards vary similarly in their spots; but in tigers there is nothing approaching the disintegration and fusion of the stripes such as occasionally occurs in the spots of leopards. So far as Asia is concerned, there are two very remarkable instances of this recorded from S. India. One of these is exhibited by the skin of a specimen shot by Mr. F. A. Coleridge at Putnam in Cuddapah and described and figured by Lydekker (*Proc. Zool. Soc.*, 1908, pp. 1-3, text fig. 1, Pl. II). The general colour is quite normal, the under side being white and the spaces between the spots tawny or yellowish buff; but the rosettes of the typical leopard are in the first place broken up into a multitude of solid spots and dots and more or less concentrated to form large blotches, variable in size and shape, each consisting of a number of dots and spots surrounded by a thickish black, mostly interrupted rim; and all over the flanks these blotches are surrounded and set off by a large-meshed network of narrow lines, paler than the ground tint of the blotches. The network nowhere crosses the spine but the blotches on the back touch or are continuous with a narrow, black, spinal stripe running

from the tail to the middle of the back and breaking up behind the shoulder into a number of narrow longitudinal black streaks which coalesce in front to form a black area running over the neck to the crown of the head. The limbs and tail are unusually heavily marked and the terminal third of the tail is black above. This skin excels that of the jaguar in the size and complexity of the blotches, the pattern recalling in a measure that of the so-called clouded leopard (Pl. II).

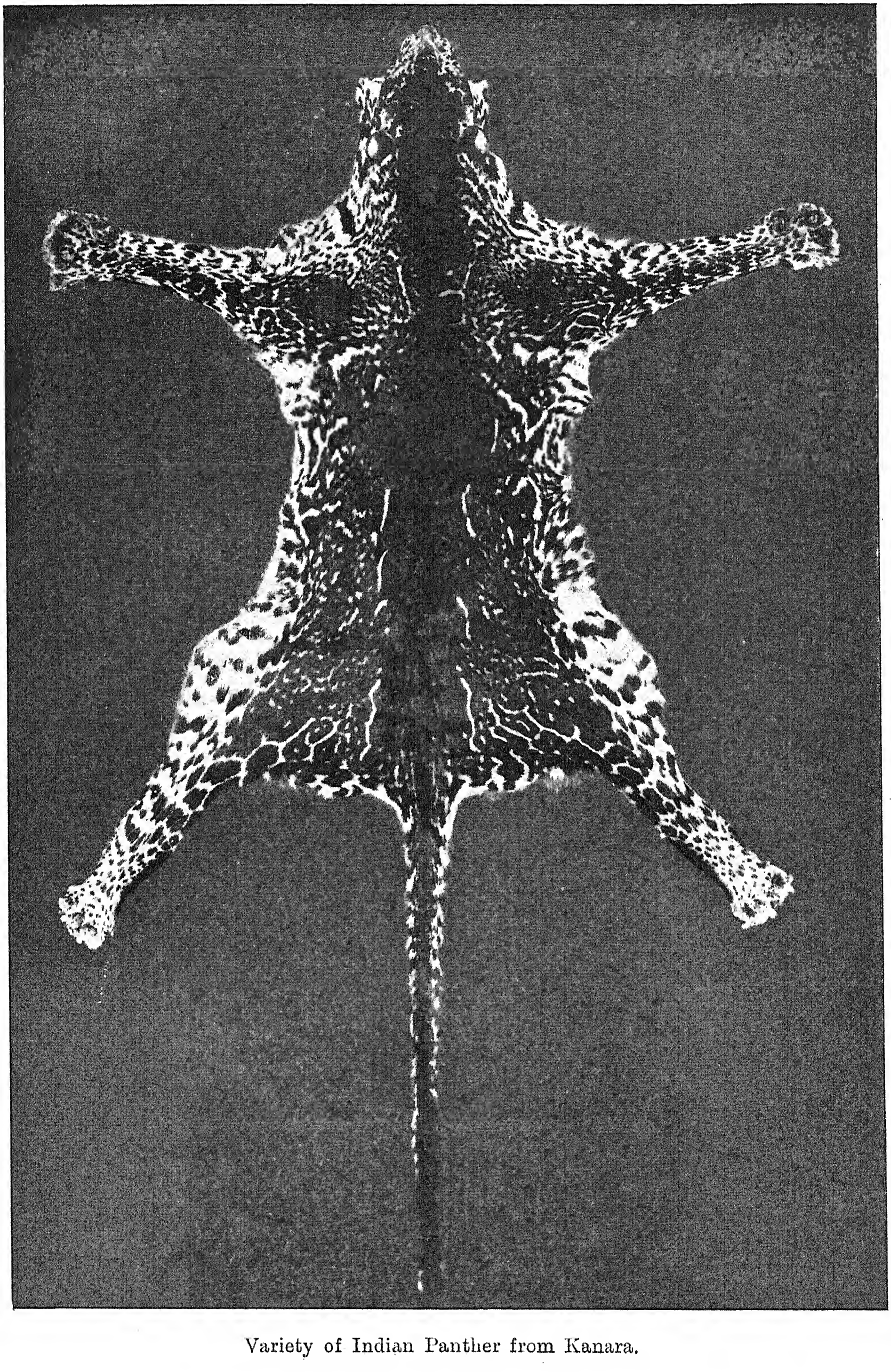
The second specimen, even more abnormal than the one just described, was shot in Southern Kanara and was secured from a native by Mr. C. A. Souter, I.C.S., who kindly lent it to me for description and illustration (*Proc. Zool. Soc.*, 1927, p. 791, text fig. I). The normal rosettes are broken up and fused to such an extent that, supplemented with additional pigment, they convey the impression of a black leopard speckled and streaked with yellow. From the crown of the head to the root of the tail there stretches a broad jet black band, here and there obscurely speckled or streaked and defined over the flanks by narrow longitudinal yellow stripes of varying length arranged subsymmetrically in two interrupted lines, one on each side. The flanks show no definite rosettes, being mostly black with yellow speckling and a few short yellow stripes, all that is left of the normal ground tint. On the thighs the blotches are more distinct and defined by zig-zag streaks recalling forked lightning. The limbs and tail are blacker than in the specimen from Putnam but the belly is white as in that variety (Pl. III).

This Kanara leopard is clearly not a 'melano', like the ordinary black leopards of the East Indies. Only near Grahamstown in South Africa do we find parallel cases of the blackening process it exhibits. Here the pattern may consist of a multitude of small solid spots on a yellow ground; or they may enlarge and coalesce to such an extent that the whole of the back and sides of the animal are glossy black, the spots only remaining distinct on the neck, the lower side and the extremities of the limbs.

Finally I may add that the red leopard skin from Hankow, presented to the museum by Mr. Ernest Poland, shows a variation of pattern somewhat like that of the specimen from Cuddapah, the spots having fused on the back and sides to form abnormally large irregularly shaped rosettes.

Indian and African Panthers

There has been a good deal of misapprehension regarding alleged differences between Indian and African panthers and leopards. Blanford, for instance, while disclaiming his ability always to distinguish the two Indian types he referred to as the bigger, paler, larger-spotted form inhabiting the hills and forests and the smaller, longer-tailed form with rougher fur and less clearly defined pattern commonly occurring in patches of grass and bushes amongst cultivated fields and gardens, said he could tell most African skins at a glance from both of these by their very much smaller spots. But I suspect his acquaintance with African leopards was restricted to the small-spotted forest type of the west coast and to Abyssinian



Variety of Indian Panther from Kanara.

skins and that he knew nothing of the larger-spotted East African types. As will be seen, moreover, from the descriptions of panther skins from India published below, some of the skins from that country have the spots quite as small as in the average small-spotted African forms.

Blandford's erroneous views on this subject were pictorially promulgated by Lydekker in Ward's *Game Animals of India,* 1924, where plates representing skins of an Abyssinian leopard, with small, colse-set spots, and an Indian leopard, with large, dark spots, are juxtaposed to illustrate the alleged differences between the animals of the two countries. But the Indian skin selected for the purpose is, in my experience, quite exceptional in the large size of the rosettes.

Another error, initiated apparently by de Winton and accepted without verification by Lydekker and other writers, is to the effect that African and Indian leopards may be distinguished by the nature of the spots on the neck, solid spots being more numerous and extending farther backwards in African than in Indian skins. This view I find repeated, for instance, in Dunbar Brander's *Wild Animals in Central India,* pp. 128-29, 1923, where the author dismisses as finally settled and buried for some time to come the idea of the existence of more than one species of leopard in India. On this head I may add that I have entirely failed to establish any constant difference between African and Asiatic leopards either in cranial or colour characters; and that I trust the view that there is more than one 'species' of this animal is buried for ever, although the existence of several environmental or local races, known as 'subspecies', cannot be ignored.

Lengths of Asiatic Panthers

Most of the recorded lengths of panthers are taken from tip to tip without distinction between the head and body and the tail. In Rowland Ward's *Records,* 1928, p. 483, for example, there are measurements on this basis of Indian panthers ranging from Kashmir and Nepal to Ceylon. Only the last on the list from Bijnor is marked as a female and she measures 7 ft. 4 in. Presumbaly the rest, varying between 8 ft. 6 in. to 7 ft. $8\frac{1}{2}$ in., the average being 8 ft., were males. It must be remembered, however, that these examples were probably measured in the field because the sportsmen who shot them thought they were exceptionally large. At all events according to Dunbar Brander (*Wild Animals in Central India,* p. 130, 1923) 'a fair average male leopard measures 6 ft. 8 in . . . the large jungle-living animal is anything from 7 ft. 2 in up to 7 ft. 9 in., a fair average specimen being 7 ft. 5 in.'

But these total dimensions are misleading as to actual size. The tail varies in length very considerably, as was long ago noticed by early writers. Hence in the case of two panthers giving the same total measurement, one with a long tail will be much smaller and less powerfully built in head and body than the other.

In this paper I have recorded the measurements of the head and body separately of most of the skins of adult specimens in the

Natural History Museum; but these are of no great value because most of the skins are probably stretched from being stripped and dressed. In the case of a few specimens, however, shot by trained collectors for the Mammal Survey or other scientifically organized expeditions, measurements in the flesh were recorded in millimetres. These, converted approximately into English feet and inches, are entered in the following table; and to this table I have added the dimensions of half a dozen specimens from Berar in India, shot and measured in the flesh by Gen. R. G. Burton (*Journ. Bomb. Nat. Hist. Soc.*, xxi, p. 1063, 1911). It will be noted that the average total length of the males of Indian panthers according to the table is just about 7 ft., 1 foot shorter than the average of the specimens measured by sportsmen and entered in Ward's *Records*.

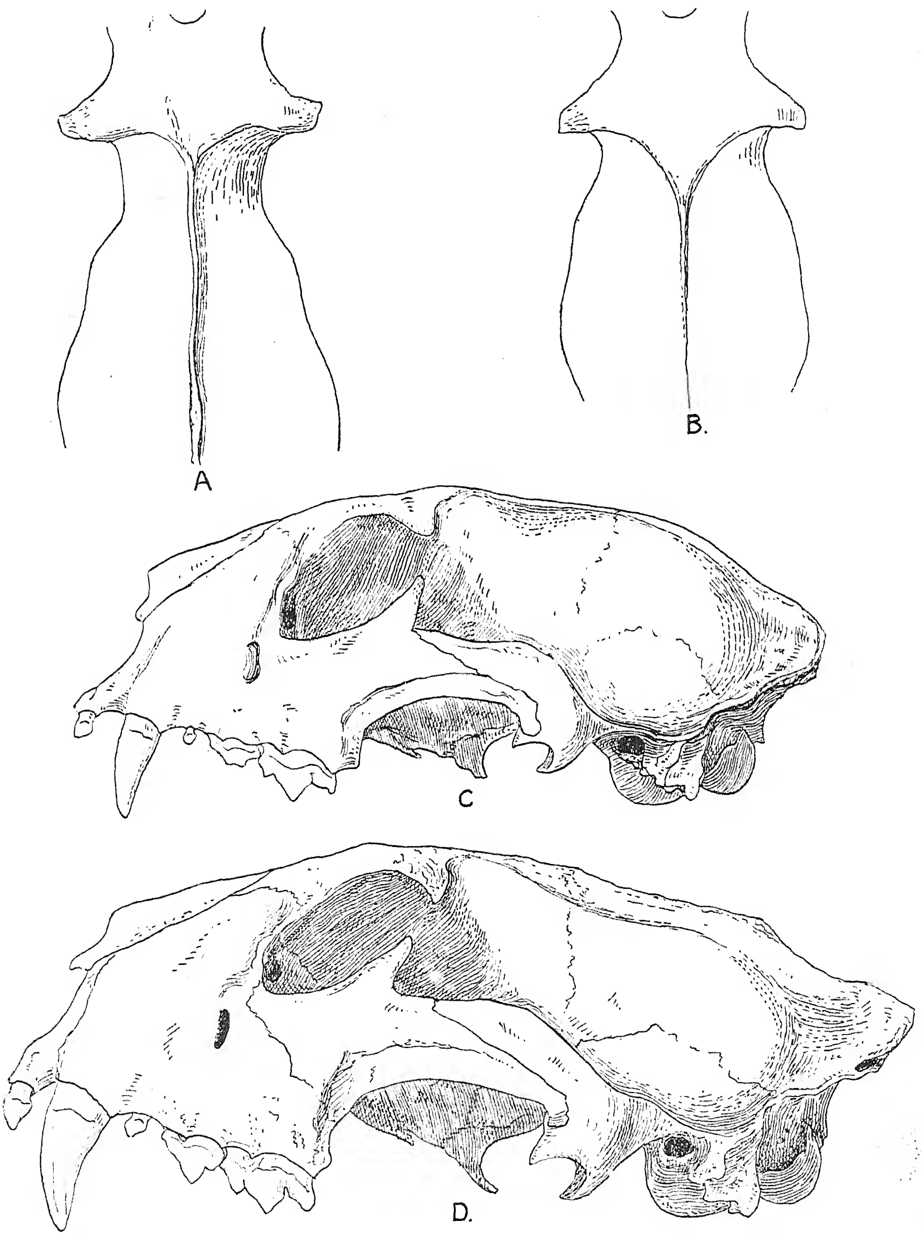
Locality and Sex			Head and Body		Tail		Total	
			Ft.	In.	Ft.	In.	Ft.	In.
Berar	♂	...	4	6	2	9	7	3
,,	♂	...	4	3	2	9	7	0
,,	♂	...	4	2	2	6	6	8
South Dharwar	♂	...	4	2	3	0	7	2
Berar	♀	...	3	8	2	6	6	2
,,	♀	...	3	7	2	7	6	2
Daltonganj	♀	...	3	5⅓	2	7	6	1
S.E. Shensi	♀	...	3	7¼	2	7	6	3
Tongoo	♀	...	3	10	2	10½	6	8½
Annam	♀	...	3	7	2	8	6	3
Java	♀	...	3	6	2	4	6	1¼

Sexual differences in the skulls of Panthers

(Pl. IV)

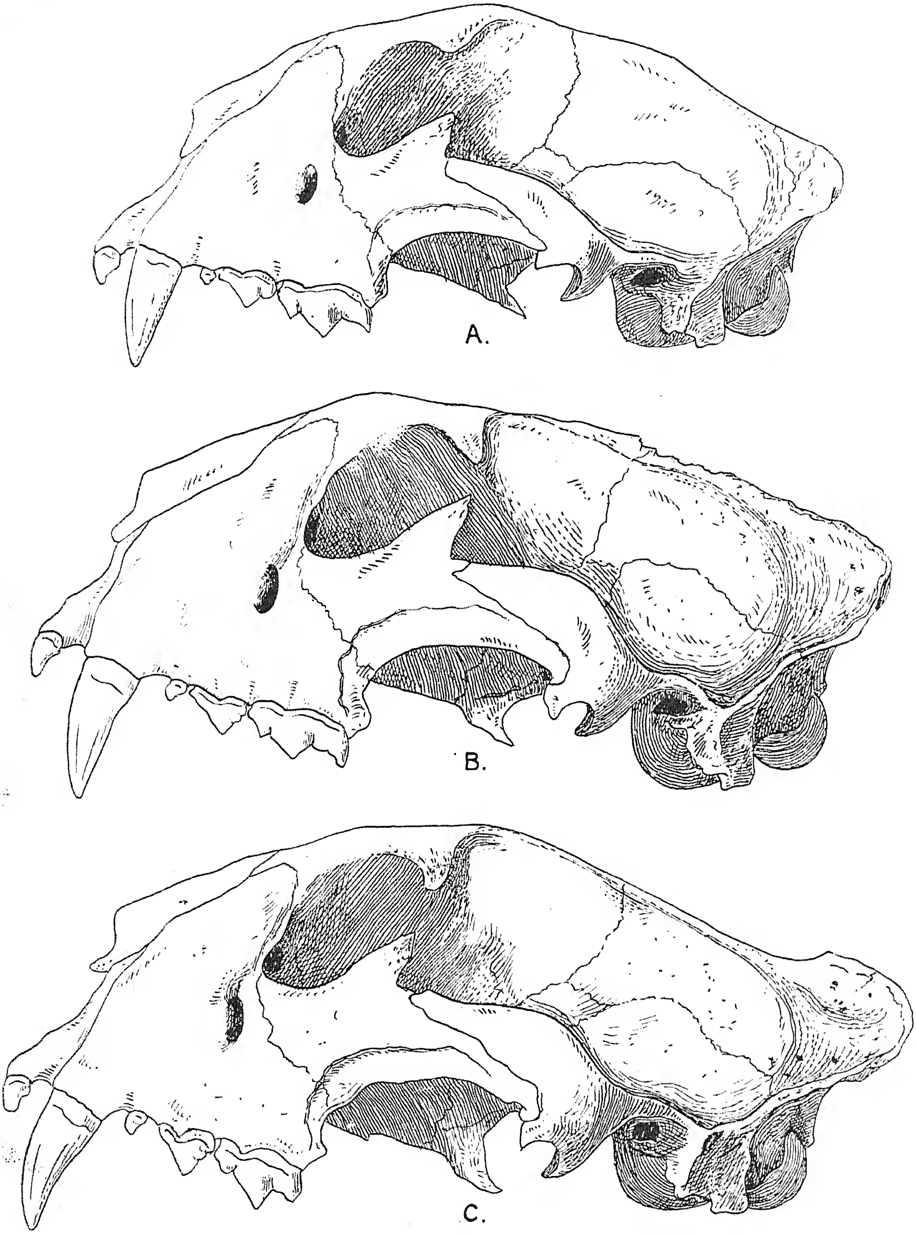
The skulls of full-grown male and female panthers differ not only in size but in shape; and these differences, as stated below, were at one time cited as evidence for the existence of two species, the panther and the leopard, in the same locality. By way of illustration of these differences I have figured on Pl. IV the skull of a tolerably old male from Ashkote, Kashmir, and of a rather older female from Nasair, Kashmir, which in the colour and pattern of their skins are approximately alike.

The male skull is much larger, has larger teeth and a less rounded cranial portion provided with a high median crest running into a more prominent occipital crest. It is also 'long-waisted', that is



A, B. Part of the upper surface of skull of adult male and female Panthers from Kashmir.
C. Side view of the female skull.
D. The same of the male skull.

(Half natural size.)



A. Skull of young male Panther from the United Provinces.
B. Skull of adult male Panther from the United Provinces.
C. Skull of adult male Panther from Bhagalpur.

(Half natural size.)

to say, the constriction of the area behind the postorbital processes is deeper and longer, being actually narrower than in the female, although the width across the interorbital region, the postorbital processes and the hinder part of the cranium is greater. The median crest too in the male skull arises much farther forwards, only a little behind the posterior border of the postorbital processes to which it is joined on each side by a low, transverse, concave ridge. In the female skull these ridges meet the very low longitudinal crest some distance behind the processes. (Pl. iv, figs. A, B, C, D.)

Although not always quite so well marked, similar differences occur between male and female skulls of adults of all races of panthers; and there is seldom any difficulty in distinguishing them. Only one skull has puzzled me. It was collected by G. C. Shortridge for the Mammal Survey at Potoli in Dharwar. It is obviously that of a full-grown animal and is ticketed as a male. Yet in all its characters it resembles a female skull, except in the size of the canine teeth which are unusually thick for that sex.

Individual and Age Variation in the Skulls of Panthers

(Pl. V)

Supplementing what was stated above with regard to cranial variations, I may add that I have failed to establish the existence of any constant differences between the skulls of the local races of panthers admitted in this paper, except in the matter of size. Skulls from the Caucasus, Persia, India and Ceylon are alike in size and do not apparently differ in character more than do individual skulls from the same province in India. On the other hand the skulls of the Chinese and Javan races are on the available evidence smaller than those of the Indian and Persian races.

But examination of several skulls of Indian panthers, presumably belonging to the same race, has shown very marked individual variations. On Pl. V, I have figured three of these side by side for comparison. Fig. A is the skull of an immature male from Bachkahi in the United Provinces (B. B. Osmaston). It is in the stage of development which is permanent in the adult female, a stage through which all male skulls pass before reaching maturity, the occipital crest being small and the median, or sagittal, crest on the cranium undeveloped. Its especial interest, however, lies in the elevation of the area just behind the postorbital processes, which is the highest point of the head. There is also a marked elevation at the point where the nasals join the frontals. Since these peculiarities are not shown by other male skulls of approximately the same age, they are clearly not attributable to immaturity but are individual variations which would doubtless have persisted without much modification throughout life.

Fig. B is an adult male skull also from the United Provinces (R. St. G. Burke). Apart from its larger size and better developed crests due to age, it differs markedly from the skull from Bachkahi in having its highest point in the interorbital region and in the absence of the swelling at the base of the nasals.

Fig. C is an adult male skull from Bhagalpur. It is very nearly

flat along the top from a point behind the postorbital processes to the interorbital region, and there are slight indications of a swelling at the base of the nasals. In these particulars it is almost intermediate between figs. A and B. It is noticeable also that the occipital crest is more prominent than in fig. B, the adult male from the United Provinces, as prominent, indeed, as that of the old male from Ashkote in Kashmir and a little deeper, whereas the sagittal crest is much lower than in that specimen and in the one from the United Provinces. This Bhagalpur skull, indeed, in its upper contour recalls the skulls of typical male Indian tigers. It is the only adult male skull I have seen from Bengal, the district whence the typical race of Indian panther came.

It may also be noticed that the Bhagalpur skull and the adult skull from the United Provinces are noticeably higher than the skull of the older male from Ashkote in Kashmir. (Pl. IV, D.) This, I believe, is due to age. From the examination of many examples I believe that the skull in both sexes tends to flatten along the top as age advances so that it becomes lower and looks longer than in those that have just reached or slightly surpassed maturity.

Some variations in the length of the nasal bones have already been described in the section discussing alleged cranial differences between tigers and panthers. But these bones vary also considerably in the shape of their upper ends, which may be either narrowed and apically pointed or broad and apically rounded. On the whole they are as a very general rule narrower and more pointed in Chinese, Malayan and Javanese than in Indian panthers; but amongst the latter there is considerable variation in this respect; and the single skull from Annam, described below, is remarkable for the width of the upper ends of the nasals and the roundness of their edges. (Pl. I, figs. F, G, H.)

Another portion exhibiting great variation is the mesopterygoid fossa on the base of the skull into which the nasal chambers open. The range of this variation is exhibited in the skulls of two female Indian panthers depicted on Pl. I. In a skull from Kashmir (fig. K) the fossa is very broad with thin arcuate lateral margins, whereas in one from Dharwar (fig. J) it is narrower and its margins are thick and parallel-sided. Every gradation between these extremes may be found in Indian panther skulls.

The Subspecies or Local Races of Asiatic Panthers

Panthera pardus Linn.

Felis pardus Linn. *Syst. Nat.* ed. 10, p. 41, 1758; and of most subsequent authors.

Panthera vulgaris Oken, *Lehrb. Nat.* pt. 3, p. 1052, 1816.

Leopardus varius Gray, *Mamm. of Brit. Mus.*, p. 40, 1843.

Analysis of the literature shows that the names *vulgaris* and *varius* are substitutes for *pardus* Linn. and therefore synonyms of it.

Since many subspecies of panthers or leopards are now admitted, it is necessary to know to which of them *pardus* Linn. belongs. This was settled by Oldfield Thomas when in his paper (*Proc.*

Zool. Soc., 1911, pp. 120-58) he showed that the first author quoted by Linnæus mentioning a locality for the species, was Alpinus who gave an account of Leopards seen alive in captivity at Cairo and Alexandria. Thomas therefore assigned *pardus* in the strict sense of the word to the Egyptian leopard which as a subspecies takes the trinominal title *Panthera pardus pardus*.

I see no reason to dissent from Thomas's decision on this point. But it was recently challenged by Allen (*Bull. Amer. Mus. Nat. Hist.*, 47, p. 248, 1924), mainly on the grounds that the specimens seen by Alpinus must have come from some point far up the Nile or from Arabia; and in support of this opinion he quoted a French author, who in 1740 declared that there are no lions or tigers or leopards in Egypt. I learn, however, from Major S. S. Flower, late Director of the Zoological Gardens in Cairo, that leopards are still found, not only in southern Sinai, which is politically part of Egypt, but also in the western desert of Egypt between Siwa and Dabaa, Dabaa being on the coast only some 100 miles west of Alexandria. Hence the leopards seen by Alpinus were probably locally captured; and the desert in question may be regarded, with good reason, as the typical locality of *Panthera pardus pardus*.

It may be added that Allen, taking Buffon and Daubenton as the first revisers, if such they can be called, of the leopards, designated Algeria as the type locality of this race. The difference is likely enough to be of no great moment, because it is more probable than not that the leopards of the western confines of Lower Egypt and of Algeria are racially identical animals. However that may be, it is clear that the typical *P. pardus pardus*, being a North African animal, falls outside the scope of the present paper.

There is only one other question to be raised in this connection. Lydekker regarded 'India' as the typical locality of *P. pardus pardus* because Linnæus added 'habitat in Indiis' to his diagnosis. This, however, is no indication of country, 'the Indies' to Linnæus being a vague term for the tropics of the eastern or western hemispheres.

The Panthers of Asia Minor, Persia and Sind

Panthera pardus tulliana, Val.

Felis tulliana, Valenciennes *CR. Acad. Sci. Paris*, 42, p. 1039, 1856; Tchihatcheff, *Asia Mineure*, pt. 2, p. 613, Pl. 1, 1856; Milne Edwards, *Rech. Mamm.* p. 214, 1867; Lydekker, *Proc. Zool. Soc.*, 1899, p. 795, Pl. 54.

Felis pardus, Alston and Danford, *Proc. Zool. Soc.*, 1880, p. 51.

Leopardus pardus tullianus, Satunin, *Mitth. Kauk. Mus.* II, p. 152, 1905; *id. Consp. Mamm. Imp. Ross.*, p. 158, 1914.

Felis pardus panthera, Lydekker in *Harmsworth's Nat. Hist.* I, p. 385, 1910. Dollman, after Lydekker, *Game Animals of India*, p. 321, 1924.

Felis pardus panthera or *tulliana* Lydekker, in Rowland Ward's *Records*, 1910, p. 500, and 1914, p. 498 (at least in part).

Felis pardus saxicolor, Dollman in Rowland Ward's *Records* 1928, p. 482 (not *Panthera pardus saxicolor*, Pocock; *cf. infra*).

Type locality.—Ninfe or Ninfi, 40 kilometres E. of Smyrna.

Distribution.—Asia Minor and Transcaucasian Russia.

Notes on synonymy.—There was at one time considerable difference of opinion about the status and characteristics of this panther. Although Valenciennes correctly described it as related to the ordinary leopard, D. G. Elliot, who examined the type in the Paris Museum, declared it to be nothing but a snow-leopard or ounce and made *tulliana* a synonym of *uncia* in his *Monograph of the Felidæ,* 1883. He was, of course, quite wrong. Tchihatcheff's figure of it leaves no doubt on that point. Nevertheless, Alston and Danford, unwisely trusting Elliot's verdict, recorded the ounce, on the evidence of what he said, as an inhabitant of Asia Minor (*Proc. Zool. Soc.,* 1877, p. 272). Fortunately Milne Edwards showed the error of Elliot's judgment, and Alston and Dandford made the necessary correction three years later (*Proc. Zool. Soc.,* 1880, p. 51), quoting the Asia Minor panther as *Felis pardus* and dissenting from M. Edward's view that it should rank as a distinct species. Later Prince Demidoff fell into the same error when he recorded the ounce from the Caucasus and gave a figure of that animal (*Hunting Trips to the Caucasus,* p. 85, 1898). This error was corrected by Lydekker who published a description and coloured illustration of a Caucasian panther, shot by Prince Demidoff, which he saw at Messrs. Rowland Ward's studios. He seems to have been a little doubtful about the name of the animal; but there are at present no data to justify its separation from *tulliana,* which according to Satunin occurs in Transcaucasia, Erivan, Armenia and Mount Ararat, and according to Danford's experience, was half a century ago generally distributed in the coastal mountainous districts of south-western and southern Asia Minor, although nowhere common.

Blanford and, following him, Lydekker regarded this panther as identical with the Persian race and as ranging from Anatolia to the confines of India. Lydekker, however, called it *panthera* following Pallas who adopted that name for the panthers of the Caucasian area (*Zoogr. Ross. Asiat.* I, p. 18, 1811). But *panthera* is inadmissible for this race. It was originally assigned by Schreber (*Säug.* III, p. 586, Pl. 99, 1777) to a female panther figured and described by Buffon and Daubenton (*Hist. Nat.* ix, pp. 160 and 174, Pl. XII, 1761), which was definitely stated to have come from Algeria.

The typical example of this panther was sent by Tchihatcheff to Valenciennes who described it as equalling the largest African leopards in size and reddish grey in colour, with a long tail gradually thickening from the root to the tip, the terminal third being tufted. Tchihatcheff's figure, taken from the mounted skin, shows the pattern to consist of large rather widely separated rosettes, mostly broken and irregular and with decidedly darkened centres.

The British Museum possesses the flat native prepared skin of an apparently adult specimen obtained by W. Forbes at Aidin in the Pachalie of Anatolia and to all intents and purposes therefore a topotype of *tulliana.* It measures 8 ft. 8 in., the head and body being 5 ft. 3 in. and the tail 3 ft. 5in. Allowing for stretching,

this probably indicates a panther of about 8 ft. from tip to tip. The hair of the skin is worn off in patches but enough remains to show that the general colour, although pale and probably somewhat faded, is decidedly tawny or buff on the back, paler on the flanks where it merges with the white of the belly. The rosettes are large, the largest up to $2\frac{1}{2} \times 2$ in., being larger, more widely spaced and thinner-rimmed than in typical Indian panthers, with their centres slightly darker than the ground tint. The coat is soft, smooth and at most slightly longer and fuller, the hair on the nape being longish, and the tail is a little more bushy than in Indian animals.

According to Alston and Danford this race 'presents considerable variety in coloration and in proportional length of tail'. The measurements they give of an adult female from Giaour Dagh near Osmanieh were :—head and body 4 ft. 11 in., tail 3 ft. 1 in., making a total of 8 ft. No doubt the skin was stretched.

The mountains of Osmanieh extend southwards to the Lebanon range in northern Palestine; and some sixty years ago leopards, according to Tristram, were common in that country even as far south as the Dead Sea. We have no information about these Syrian leopards. They may be identical with the Asia Minor race. But equally well they may be identical with the leopards of Sinai and western Egypt, which I regard as typical *Panthera pardus*. The panther of Asia Minor (*tulliana*) is, however, certainly distinct from the panther of Sinai.

I have seen only one skull assignable to *tulliana*, namely, that of the female from Osmanieh obtained by Danford, which is in the British Museum. But Satunin records two skulls from Erivan in the northern portion of Asia Minor. The dimensions of these three skulls are as follows :—

	Inches				Millimetres		
Locality & Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
Erivan, ♂ ...	10·2	8·3	6				
,, , ♀ ...	8·2	7 –	5·3				
Osmanieh, ♀ ad.	8·2	7·5	5·2	2·5 × 1·3	23	17	13

The sexes of Satunin's skulls are unstated; but I assume from their dimensions they were male and female. I can find no difference between the skull from Osmanieh and skulls from India, and the dimensions show that this panther from Asia Minor is as large as any recorded race.

Panthera pardus saxicolor, Pocock

(Pl. VI)

Felis leopardus, P. L. Sclater, *Proc. Zool. Soc.*, 1878, p. 289. (Not *leopardus*, Schreber).

Felis tulliana, Blanford (in part); not *tulliana,* Valenciennes.

Felis pardus panthera or *tulliana,* Lydekker (in part); not *panthera,* Schreber.

? *Leopardus pardus ciscaucasicus, Satunin, Consp. Mamm. Imp. Ross.,* p. 159, 1914.

Panthera pardus saxicolor, Pocock, *Ann. Mag. Nat. Hist.* (9), xx, p. 213, 1927.

Locality of type.—Asterabad in Persia.

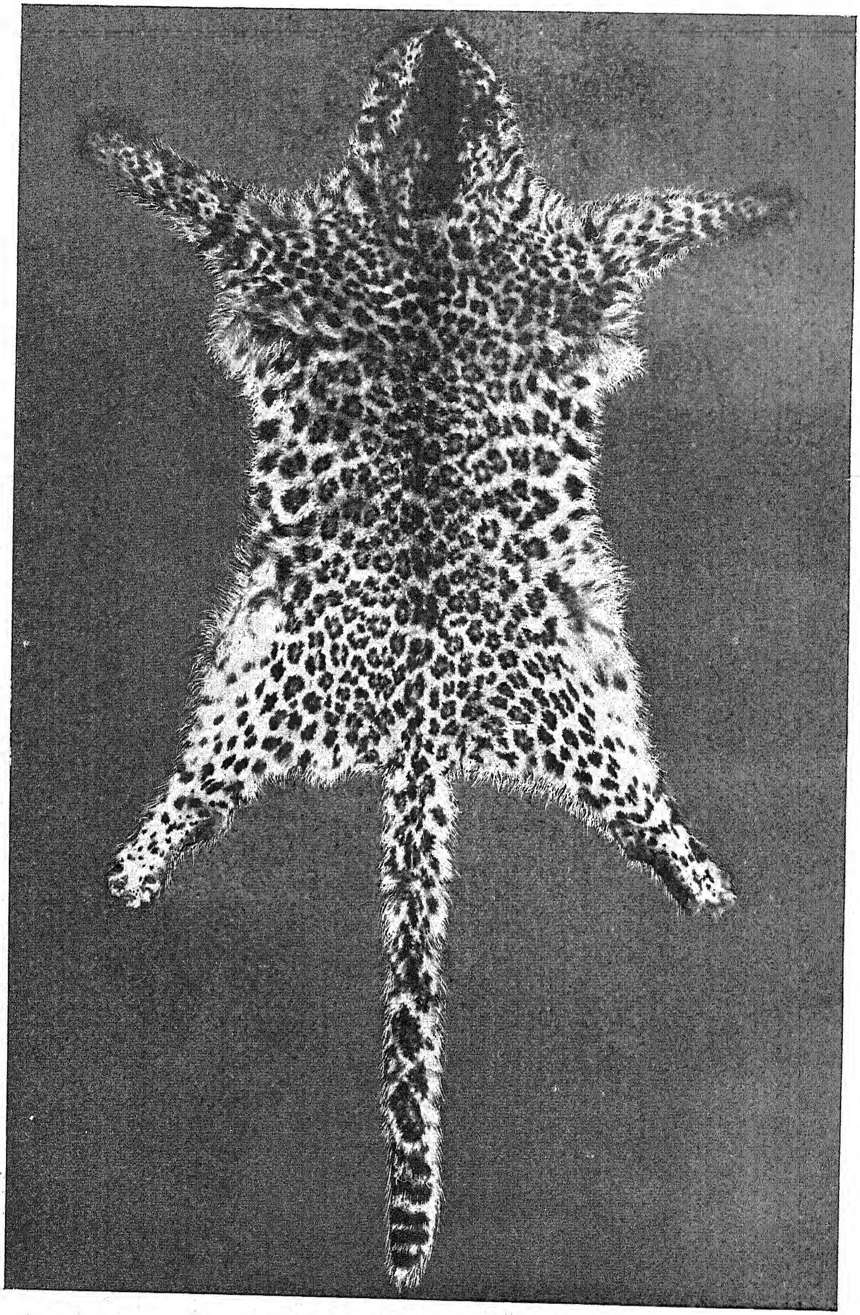
Distribution.—Persia eastward at least to Seistan.

Notes on the synonymy.—This panther has long been known and there are probably many earlier records of it than the one that heads the list of synonyms; but it has passed under inadmissible names, being regarded by Blanford and Lydekker as identical with the race inhabiting Asia Minor. I have interrogatively inserted the name *ciscaucasicus* into the synonymy because Satunin's very brief description of that race as differing from *tulliana* in being smaller, greyer and without any reddish shade, applies so far as it goes to the Persian animal. But as its name *ciscaucasicus* indicates, this panther inhabits southern Russia, north of the Caucasus, the type specimen coming from the Province of Kuban by the Sea of Azov. Apparently only one specimen was available. This was thick coated, the hair being up to 1 inch in length. Its head and body measured 5 ft. 3 in. and its tail 3 ft. 1 in., making a total of 8 ft. 4 in.; the basal length of the skull was 7·7 in., and the zygomatic width 6 in. The skin measurements have little value; but the cranial measurements agree very closely with those of the male example of *tulliana* from Erivan cited by Satunin, and hardly justify his description of this European leopard as smaller than the leopard of Asia Minor. There this race must be left, and pending further information regarding it, I think it wiser to retain for the Persian panther the name *saxicolor* which I gave it in 1927.

Of this Persian race I have seen several skins from the following localities :—

Asterabad. A mounted adult male (Type) in the British Museum, presented in 1882 by Lt.-Col. Beresford Lovett and identified by Lydekker as *tulliana.* The general colour is whitish grey very faintly washed with buff on the flanks, a little more deeply on the back, but without any trace of it on the head or limbs, the limbs being whiter than the head. The rosettes are of moderate size and moderately widely spaced and are smaller, thicker-rimmed and less annular than in *tulliana,* and deep chocolate brown in colour; the largest on the flanks measure about 2 × $1\frac{1}{4}$ in. but are mostly about $1\frac{1}{2}$ × $1\frac{1}{2}$ in. in diameter. The coat is full, thick and soft, with a considerable quantity of underwool; on the back it is about $1\frac{1}{4}$ in long, on the belly over 2 in., and on the middle of the upper side of the thick, bushy tail about $1\frac{1}{4}$ in. The skin, as mounted, measures: head and body 4 ft., tail 2 ft. 9 in., making a total of 6 ft. 9 in.

Rowanduz, near Sulaimaine in Iraq Kurdistan (Capt. Littledale). This skin is more richly tinted than the Asterabad skin described



Persian Panther (*P. pardus saxicolor*).
Skin from Pusht-i-Kuh, winter coat.

above and than the other Persian skins recorded below, linking them with typical *tulliana*.

Pusht-i-Kuh Range in Luristan. Three skins.

(1) Flat skin, in summer coat, belonging to Mr. C. E. Capito, and measuring: head and body 49 in., tail 37½ in., total 7 ft. 2½ in. Coat short, close and smooth with very little underfur, the hair on the back and on the middle of the upper side of the tail is about ¾ in. long, on the belly 1 in. The ground colour is a pale stone-grey, slightly darker and faintly tinged with buff on the back and in the centres of the rosettes, colour of flanks passing imperceptibly into white of belly. Rosettes black, showing up conspicuously against the grey tint, not large, largest about 1½ by 1 in. in diameter, moderately spaced, the intervals about ½ in. on flanks. This panther was shot in the hilly country to the N. E. of Dizful.

(2) Skin of a subadult or adult male also in summer coat (Sir Percy Cox and Capt. Cheesman) and measuring: head and body 56 in., tail 35 in., total 7 ft. 7 in. The coat is about the same length as in Mr. Capito's skin, but the colour is not so grey, being creamy-buff, and more resembling the skin from Rowanduz than either of the other two above described Persian skins.

(3) Skin in winter coat, from Marsh Ao Gorge, 1,000 ft. alt., at the S.E. end of the Pusht-i-Kuh territory, kindly lent to me by Mrs. Lane and measuring: head and body 44½ in., tail 32 in., total 6 ft. 4½ in. Coat long, thick, woolly, showing distinct inclination to tufting, 1½ in. on back, 2 in. on belly and 1¾ in. in middle of upper side of tail. Colour almost as grey as in Mr. Capito's skin in summer coat, the rosettes less conspicuous on account of the roughness of the coat and of their colour which is brown as in the specimen from Asterabad. (Pl. VI.)

Mishun in the western part of the Province of Fars, approximately 51° E. and 30° N.

(1) A flat skin kindly lent by Mrs. Lane and measuring: head and body 56 in., tail 29½ in., total. 7 ft. 2½ in. The tail which is apparently complete being comparatively short. Coat in length and quantity of underwool intermediate between the summer and winter coats exhibited by the skins from Pusht-i-Kuh and similar to the coat of the specimen from Asterabad. The colour is also as in the latter and not so washed out as Mr. Capito's skin from Pusht-i-Kuh.

(2) Head-skin, with skull, belonging to Mr. Capito, a little darker than the head of his skin from Pusht-i-Kuh.

(3) The undressed skin of a female, from Chak-i-Buzza Pa near Mishun, about 2,500 ft., belonging to Mrs. Lane and measuring: head and body 50 in., tail 32 in., total 6 ft. 10 in., closely resembles the complete skin from Mishun.

Seistan, Palang Kuh. An imperfect skin, in winter coat, presented to the British Museum by Col. R. L. Kennion. Coat long, soft and very woolly breaking up into tufts as in the skin in winter coat from Pusht-i-Kuh, but the coat is thicker and more tufted and the rosettes are blacker. Colour pale and washed out, buffy grey on flanks and back, pure white below. The general appearance of the skin is very ounce-like both in colour and coat.

In Col. Kennion's *By Mountain, Lake and Plain,* p. 267, 1911, Lydekker referred to this skin as representing an undescribed variety of leopard.

I have only seen one skull of this panther, namely, the skull of an adult male, accompanied by the head skin, brought by Mr. C. E. Capito from Mishun. Its measurements are as follows :—

	Inches				Millimetres		
Locality & Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Canine
Mishun ♂ ...	9·6	8·6	6·1	2 8 × 1·6	26	20	16

These measurements, as well as those given of the skin, show that the Persian panther is as large as the typical Indian panther. The skull, however, presents no distinguishing racial characters. In its general form, indeed, it is more like the skulls of two Indian panthers, namely, one from the United Provinces collected by Mr. R. St. G. Burke, and one from Mundiapani in Garwhal, collected by Mr. B. B. Osmaston, than these are like many another Indian skull.

I gladly take this opportunity of expressing my indebtedness to Mr. C. E. Capito not only for the loan of the skin and skull of his own specimens of this panther but for asking Mrs. Lane to lend me the three skins in her possession, a request she most willingly and promptly granted.

According to Mr. Capito these panthers in South Persia inhabit caves and gorges in the barren limestone and gypsum hills down to about 900 ft. Singularly enough there is no reference to this panther in the papers on the Mammals of Mesopotamia and Shiraz by Major R. E. Çheesman and Capt. C. R. S. Pitman printed in *A Survey of the Fauna of Iraq* published by the Bombay Natural History Society in 1923.

To this race belonged a pair of living panthers brought by Capt. Phillips from the Persian Gulf and presented to the Zoological Society in 1878. Dr. Sclater described them as being 'remarkable for their long, hairy coats, bushy tails and pale body colour which remind one rather of the ounce (*Felis uncia*)'.

Panthera pardus sindica, subsp. nov.

Felis tulliana, Blanford, *Mamm. Brit. India,* p. 69, 1891 (in part).

Felis pardus panthera and *F. pardus panthera* or *tulliana,* Lydekker, following Blanford (in part).

Type locality.—Kirthar Range on the Sind-Baluchi boundary.

Distribution.—Elsewhere unknown.

Resembling and no doubt completely intergrading with the Persian panther and distinguishable from the typical Indian form in coat and coloration.

Coat not soft, smooth and flat, but harsher and rough, almost as if singed, with a considerable quantity of underwool; hair on the back about 1 in. long, on the belly about $1\frac{3}{4}$ in. and on the upper side of the middle of the tail about $\frac{3}{4}$ in. Colour of the fulvous-buff type, richer than in the typical Persian panthers but very decidedly paler than in the average Indian form, the flanks washed with buff, which becomes intensified on the back; the rosettes show up everywhere against the pale ground on account of their large size, wide spacing and darker centres, the largest being about $1\frac{1}{2} \times 1\frac{1}{2}$ in. in diameter, with the interspaces frequently as much as $\frac{3}{4}$ in.; on the average they are narrow-rimmed and inclined to be annuliform.

The only known skin of this race, that of a young male, measures: head and body 4 ft. 2 in., tail 2 ft. 10 in., total 7 ft.

The dimensions of two skulls are as follows :—

	Inches				Millimetres		
Locality & Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
Kirthar Range ♂ (young) ...	8·4	—	5·2	2·5 × 1·2	24	17·5	14·5
,, ♀ ad	7·7	7	4·9	2·1 × 1·2	23	17	12

There is nothing remarkable about these skulls. Neither in shape nor size do they appear to differ from the skulls of either Persian panthers to the west or of typical Indian panthers to the east.

The specimens upon which this subspecies is based were collected by H. E. Watson who gave them to Blanford and he in turn presented them to the Natural History Museum; and it was the skin above described that Blanford apparently had before him and identified as *tulliana* when he wrote (*Mamm. Brit. India,* p. 69): 'There is a race inhabiting Persia and found in Baluchistan and the mountains of Sind that differs widely from all the others and is quite intermediate in coloration and spotting between the leopard and the ounce.' This statement is certainly not true of the skin from the Kirthar Range which is much more richly tinted than any ounce and has smaller and many more spots. Blanford probably knew, at least by hearsay, of the grey Persian leopard, which approaches the ounce in colour but emphatically not in pattern; but he did not distinguish the Persian from the Sind type. He may have compared the Kirthar Range skin with the skin of *tulliana* in the British Museum, which was available for examination. This would account for his identification of the Sind race with the one inhabiting Asia Minor. There is certainly great similarity between the two in colour and pattern, although the Sind specimen is not apparently quite so pale; but there is a great difference in the texture of the coat. More material of the two races will no doubt reveal further differences because there is apparently complete

distributional discontinuity between the two, the greyer Persian race (*P. pardus saxicolor*) dividing them over a wide area of longitude. It may be added that the Sind race differs from the typical Persian race in its harsher coat, brighter colour, and thinner-rimmed, larger, more widely spaced and therefore more conspicuous pattern.

Although this panther is strictly speaking Indian in a political sense, its affinities appear to be certainly nearer to the Persian type than to the panthers and leopards known to Indian sportsmen. I have therefore excluded it from the following section in which these are discussed.

To this subspecies I also refer the skin of a half-grown specimen obtained by Capt. J. E. B. Hotson on the Perso-Baluchi border, no precise locality being recorded on the label. It is rougher coated and the spots are smaller and much less clearly defined than in the example from the Kirthar Range. Those, however, are common features in immature skins. The colour, nevertheless, is decidedly yellowish tawny as in *tulliana*. But possibly this skin may belong to the more northern paler race, *saxicolor*.

(*To be continued*)

Lignum vitae Tree.
Guaiacum officinale, Linn.

SOME BEAUTIFUL INDIAN TREES

BY

E. BLATTER, S.J., PH.D., F.L.S. AND W. S. MILLARD, F.Z.S.

PART III.—(*With two coloured plates, two black and white plates and 4 text-figures*).

(*Continued from page 856 of Vol. XXXIII.*)

THE LIGNUM VITAE TREE

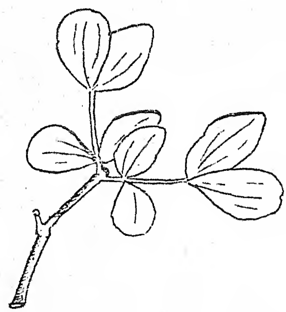
Popular names : Guaiacum (West Indies). Lignum Vitae Tree.

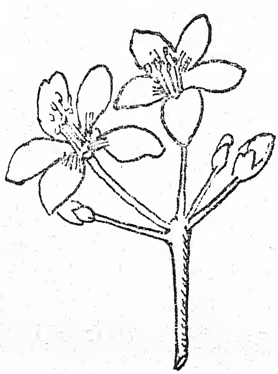
Guaiacum officinale. Linn. Sp. Pl. 381.

The genus *Guaiacum* contains 4 species of trees or shrubs all indigenous to Tropical America.

Description : The Lignum Vitae Tree grows to a height of 30 to 40 feet. The stem is generally crooked, the wood intensely hard, the branches knotty and the bark deeply furrowed.

The dense crown of close-growing foliage gives the tree a rounded, compact, neat appearance. It is distinctly ornamental on a lawn. Each leaf is composed of two or three pairs of smooth, stalkless, leaflets arranged on a slender mid-rib. The leaflets are from $\frac{1}{4}$–$\frac{1}{2}$ inch in length. There is much irregularity both in their size and shape : some are rounded at the apex (obovate), others almost blunt (obtuse).





The tree flowers at the end of the cold season and the commencement of the hot weather. In Bombay some of the trees are in bloom the whole year round. The beautiful blue flowers grow in great profusion. They almost cover the tree. The flowers remain for a long time. As the older blooms fade from deep blue to paler shades, some

becoming almost white, a striking variegation of colour is produced. The flowers grow in clusters at the end of the branches. Each flower has five petals cupped in a small, finely hairy calyx, supported on a slender stalk. There are ten stamens bearing golden yellow anthers.

The fruit appears as small, round, compressed capsules containing 5 cells; occasionaly there are fewer. Each cell encloses a single seed.

Distribution: The Lignum Vitae Tree is an inhabitant of the islands of the West Indies, from whence it was introduced into India. It also grows in the arid plains stretching from the Florida Keys to Venezuela.

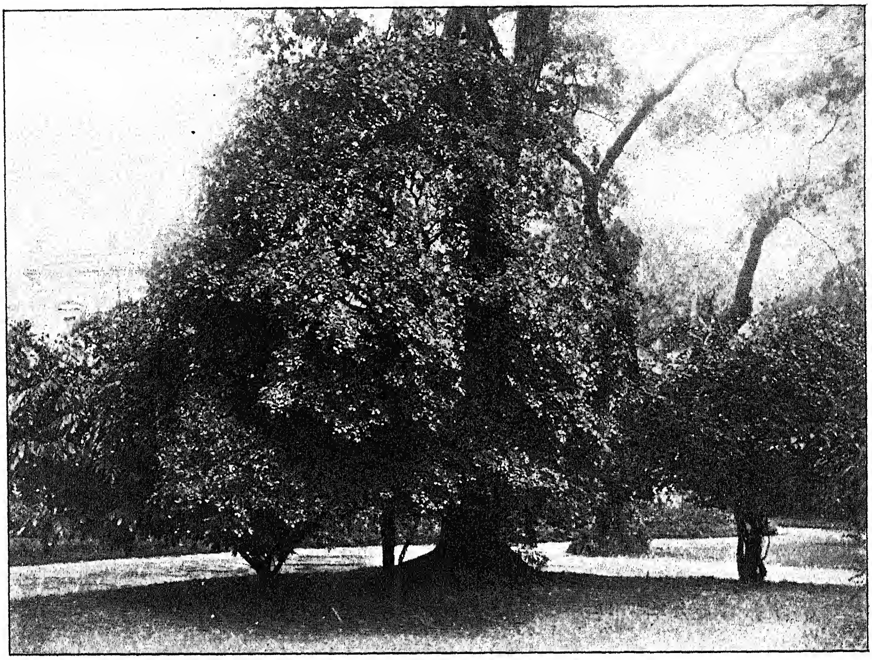
Gardening: Raised from seed. For many years we knew of only one tree in Bombay which was growing in the compound of the Jamsetjee Jejeebhoy Hospital. This had been introduced, we were told, by Dr. Wellington Gray from the West Indies. Seeds were obtained from this tree by the late Mr. H. V. Kemball and now it is a fairly common tree in gardens in Bombay. It succeeds well at Madras and Bangalore, though at the latter station it is rare and somewhat stunted in growth.

Uses: The wood, called Lignum Vitae (Pockholz or Franzosenholz by the Germans) reached Europe *viâ* Spain probably towards the end of the fifteenth century. Soon it became famous as a remedy against the 'Morbus Gallicus', and was praised as such in numerous books of which the most important is: Ulrici de Hutten Eq. *De Guaiaci medicina et morbo gallico liber unus. Moguntiae* 1519.

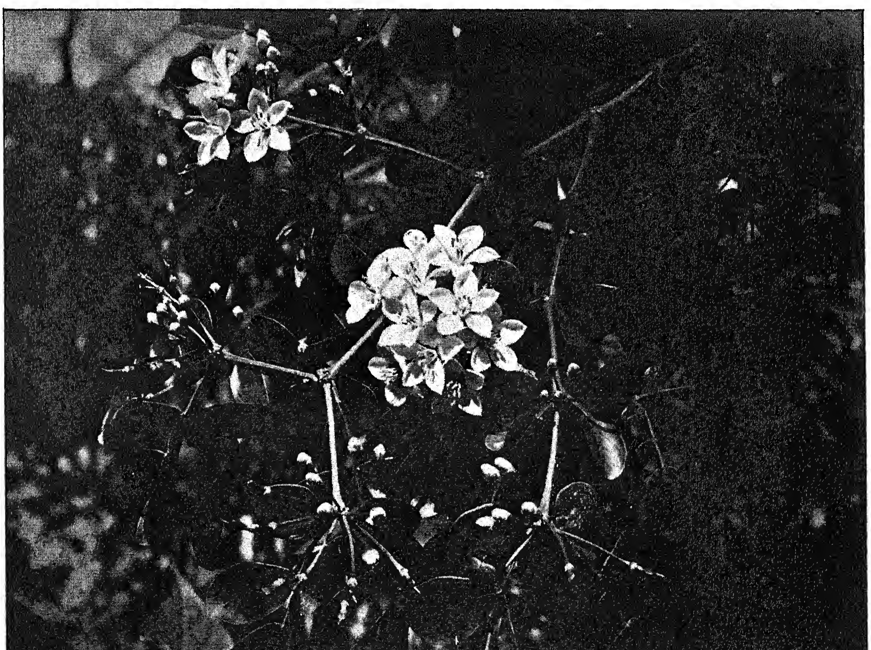
The heart-wood is greenish brown, the sap-wood pale yellow. It is remarkable for the direction of its fibres, each layer of which crosses the preceding diagonally. It sinks in water. It is of great value and is used for many purposes, chiefly by turners. Ship's blocks, rulers, pulleys, skittle-balls, bowls are among the articles made of it. When rubbed and heated, it gives off a faint, disagreeable aromatic odour. Its taste is pungent and aromatic. Shavings and raspings of the wood are used by apothecaries for medicinal purposes. In the same way the bark is employed in medicine. The most important product is a resin obtained from the wood and bark, and used in powder, pill and tincture. It is an acrid stimulant and has been found efficient against various diseases. The resin is an ingredient of the well-known Plummer's Pills. It is also one of the chief means employed to detect blood stains.

The resin sometimes flows spontaneously from the stem of the tree; at other times, it is obtained artificially by jagging or notching the stem and allowing the exuding juice to harden, or by boring holes in logs of the wood and then placing them on a fire so that the resin is melted and runs through the hole, or by boiling the chips in salt and water, when the resin floats on the surface of the water.

The resin is greenish brown in colour and has a brilliant resinous fracture. Of taste there is scarcely any, but it leaves a burning sensation in the mouth.



The Lignum Vitae Tree (*Guaiacum officinale*).



Photos by C. McCann.

Flowers of the Lignum Vitae Tree (*Guaiacum officinale*).

INDIAN CORK-TREE.
Millingtonia hortensis, Linn. f.

THE INDIAN CORK TREE

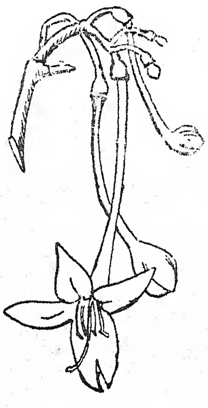
Popular Names: Indian Cork Tree; The Tree Jasmine. Cowla nim (Mar.); Nimi-chambel (Mar.); Akas-nim (Hind.); Kat mali (Tam.); Kavuki (Tel.); Egayit (Burm.).

Millingtonia hortensis. Linn. f. Suppl. (1781) 291.

Description: An elegant, straight tree reaching as much as 80 feet in height, with drooping branchlets and a graceful elongate crown of deep green foliage. Its yellowish grey bark is cracked and furrowed in various directions with corky fissures.

The foliage is very handsome. The leaves attain a length of 2-3″. They are described as bi-pinnate or tri-pinnate, that is, each leaf is composed of two to three pairs of pinnae or minor leaves arranged in pairs along the main rib. The pinnae bear smooth, oval or lance-shaped leaflets, 2–3″ long. The young shoots are slightly hairy below. Though never completely bare, the Cork tree sheds a good proportion of its leaves between January and March and renews its foliage between April and May.

In Bombay and the Konkan, flowering commences about the end of October and continues right into December; in other parts of W. India trees flower in August and September. Decked in drooping masses of snowy white flowers which stand out against the dark foliage, the tree presents a beautiful appearance. Like many of the members of its charming family, the *Bignoniaceæ* (Trumpet Flowers), the flowers have a delightful fragrance which fills the surrounding air. The flowers grow in large panicles at the end of the branchlets. The tiny bell-shaped calyx bears the pendant, slender tube-like flower. This tubular portion is from 2–3″ long and of a faint green tinge; it expands into waxy white petals. These are sometimes flushed with pink. The petals are oval, pointed at the apex and the largest of them is deeply cleft. There are four stamens crowned with yellow anthers. The style protrudes well beyond the petals. The fruit is slender, compressed and pointed at both ends. It grows to a foot and a half in length.



The seeds are flat. They measure an inch across. Each seed is surrounded by a tender wing which is narrowed at the top and absent

at the base. The tree does not produce fruit in Western India or in the Central Provinces.

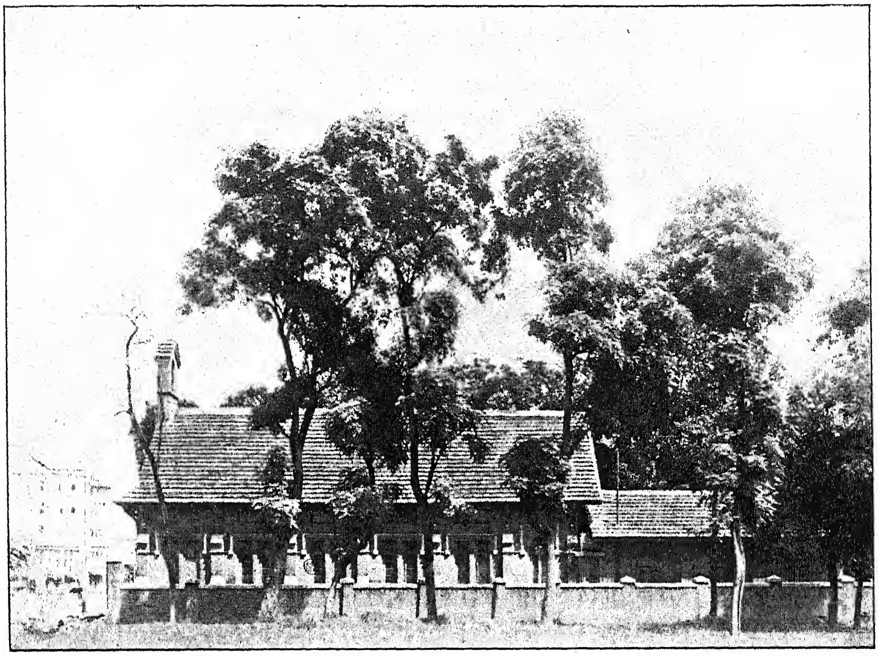
Distribution : The Indian Cork Tree is believed to be indigenous in the tropical forests of Burma from Ava to Tenasserim and the Malay Archipelago. It is cultivated largely in many parts of India and runs wild in certain areas of Central India as in the valley of the Godavari river. Roxburgh mentions that about 1800, seeds of this tree were brought to Madras from the gardens of the Raja of Tanjore from whence a plant was also procured for the East India Company's Botanic Garden at Calcutta.

Gardening : It is a fairly common roadside tree in Western India. Though ornamental, it is not very suitable for avenues, as it is tall rather than spreading. The tree is fast growing. The specimen in the Botanic Gardens at Calcutta, to which we refer, reached a height of 50 ft. in twelve years.

'The tree is decidedly hardy, and is not particular as to soil; although it grows best in a moist climate, it does fairly well in dry situations. It is, however, brittle and shallow-rooted, and is liable to be broken or uprooted by strong winds. It has a tendency to send up root-suckers in great profusion, which is a disadvantage in gardens. It is easily raised from seed when obtainable, from cuttings put down in the spring or from root-suckers put down and transplanted during the rainy season. Seed should be sown in the nursery as soon as it ripens, towards the end of the hot season, and the seedlings, which bear transplanting well, should be planted out a year later at the biginning of the rainy season.' (Troup).

Uses : The wood is soft and yellowish. It is close-grained and takes a fine polish and is used for furniture and ornamental work. From the bark, which is about an inch thick, an inferior kind of cork is made.

(*To be continued*)



Indian Cork Trees (*Millingtonia hortensis*) on roadside in Bombay.

Photos by C. McCann.

Flowers of the Indian Cork Tree (*M. hortensis*).

INDIAN DRAGONFLIES

BY

F. C. FRASER, LT.-COL., I.M.S., F.E.S.

Part XXXV

(*With one plate and four text-figures*).

(*Continued from page 850 of Volume XXXIII*).

Genus : LESTES.—*Continued.*

Lestes orientalis, Hagen (1859).

Lestes orientalis Hagen, *Syn. Neur. Ceylons*, No. 119, Zool. bot. Gesell. Wien. (1859) ; Selys, Bull. Acad. Belg. (2) xiii, p. 322 (1862) ; Kirby, Cat. Odon., p. 163 (1890) ; Id. Journ. Linn. Soc. Zool. xxiv, p. 566 (1893) ; Laid. Rec. Ind. Mus., vol. xix, p. 155 (1920) ; Id. *Spolia Zeylanica*, vol. xii, p. 357 (1924).

Male. Abdomen 52 mm. Hindwing 38 mm.

Head : labium yellow ; labrum, cheeks and bases of mandibles pale yellow, rest of head coppery bronze or green metallic ; eyes brown ; behind head pale yellow.

Prothorax and thorax metallic green bronze on dorsum with ante-humeral stripes pale yellow on the latter ; laterally and beneath pale yellow with two brown spots on each side of chest.

Legs black, bases of femora paler, especially on flexor surface.

Wings hyaline, forewings with 18–20 postnodal nervures ; *IRiii* not zigzagged ; pterostigma dark yellow framed in black nervures, covering from 2 to 2½ cells.

Abdomen green metallic on dorsum and sides ; anal appendages black superiors forcipate, apices curving towards each other and terminating in a point, furnished near the base with a blunt spine, and, at about the middle, a small tubercle below. Inferiors rudimentary, conical, very short.

Female. Abdomen 49 mm. Hindwing 40 mm.

Closely similar to the male, differing only in sexual characters ; segment 10 brown, notched at its apical border. Anal appendages conical, pointed at apex ; vulvar scale yellow, extending to end of abdomen, with serrate border.

Distribution. Rhambodda Pass, Ceylon. Type in the Hagen collection. This species, which greatly resembles a Megalestes, must be either extremely local or very rare as it has never been taken since the type was procured in 1858, seventy years ago. It differs from *Magalestes major* by the presence of intercalated sectors between *IRiii* and *Riv + v*, but is possibly closely allied to it. It is to be hoped that some one of the entomologists in Ceylon may re-discover this beautiful and interesting insect.

Lestes barbara, Fabr., (1798). (Pl. I. 1.)

Agrion barbara Fabr., Suppl. Ent. Syst., p. 286 (1798) ; Fonscolomb, Ann. Soc. Ent. France, vii, p. 554, t. 33, fig. 2. (1838).

Agrion barbarum Charp., Hors. Ent., p. 9 (1825) ; Id. Libell. Eur., p. 142, t. 35, figs. 3 and 4 (1840).

Agrion nympha Hansem, Wieden. Zool. Mag. ii (1), p. 161 (1823).

Lestes barbara (♀) Lind. Mon. Lib. Eur., p. 36 (1825) ; Selys (♂ et ♀), Mon. Lib. Eur., p. 142 (1840) ; Ramb. Ins. Nevrop., p. 251 (1841) ; Selys. Rev. Odon., p. 159 (1850) ; Id. Bull. Acad. Belg. (2) xiii, p. 318 (1862) ; Laid. Rec. Ind. Mus., vol. xix, p. 155 (1920).

Lestes barbarus Kirby, Cat. Odon., p. 162 (1890) ; Calv. Proc. Acad. Nat. Sci. Philadelph., p. 147 (1898).

Male. Abdomen 26–34 mm. Hindwing 21–25 mm.

Head : labium pale brownish white ; labrum, cheeks and bases of mandibles yellowish or pale olivaceous ; penultimate joint of antennæ and behind eyes yellow ; rest of head dark bronzed green with a coppery or golden reflex ; eyes brown.

Prothorax green metallic on dorsum, yellow at the sides and finely along borders of posterior lobe, which is rounded, very small and narrow. A black spot low down on each side.

Thorax brilliant metallic green on dorsum as far lateral as the middle of mesepimeron ; old specimens with a golden or coppery reflex ; dorsum marked with a narrow humeral yellow stripe narrowly bordered with black. In Kashmir examples this black border is more extensive, so that in some specimens the yellow line is greatly narrowed at its middle or entirely obliterated by a confluence of the black borders. Middorsal carina finely yellow in European examples, dull black in Kashmir ones. Laterally and beneath bright citron yellow from beyond the middle of mesepimeron ; postero-lateral suture finely mapped out in black.

Legs yellow, femora and tibiæ with a narrow black line on the outer side, flexor surface of tibiæ black, tarsi black.

Wings hyaline, palely tinted with yellow ; pterostigma bicolorous, rather more than the proximal half blackish brown, outer part white or creamy, braced, covering 2 cells, framed in thick black nervures, 1·5 mm. in length ; 10–14 postnodals to forewings, 10–12 in the hind ; *Riii* arising 2½ to 3 cells beyond the node in both wings ; *IRii* arising 7 cells after the node in forewing, 5 in the hind.

Abdomen yellow at the sides, metallic green to coppery on the dorsum and with narrow apical rings to most segments ; segment 2 with the middorsal carina finely yellow ; segments 3 to 6 with narrow basal yellow rings often interrupted at the middle line ; segment 10 matt black on dorsum, non-metallic, yellow at the sides, pulverulent white on the dorsum in old specimens.

Anal appendages. Superiors yellow tipped with black, Kashmir examples being yellow at the base and outwardly only, the whole of inner side including the basal tooth and the apex being black ; ratler longer than segment 10, forcipate, the apices curling in with rounded overlapping ends, a robust inner basal spine followed by a shell-like dilatation minutely denticulated on its inner free border. Inferior appendages yellow finely tipped with black, thick, tumid and apposed at bases, then strongly divaricate, markedly tapered, turned up to end in a fine point.

Female. Hindwing 22–27 mm. Abdomen 29–33 mm.

Similar to the male except for sexual differences. A small oval yellow spot on the outer side of each posterior ocellus ; occiput bordered narrowly with yellow ; humeral stripe not bordered with black, the Kashmir examples not differing from type in this respect ; legs rather more broadly striped with black ; wings similar to male, 11–14 postnodal nervures to all wings ; abdomen coppery bronze on dorsum, segment 10 yellow with a rather narrow well-defined blackish brown stripe on dorsum, which, in some, tapers to the apical border of segment.

Anal appendages yellow, tipped with black in Kashmir specimens, conical, pointed, slightly shorter than segment 10. Vulvar scale very robust, yellow or yellow bordered with black in Kashmir specimens.

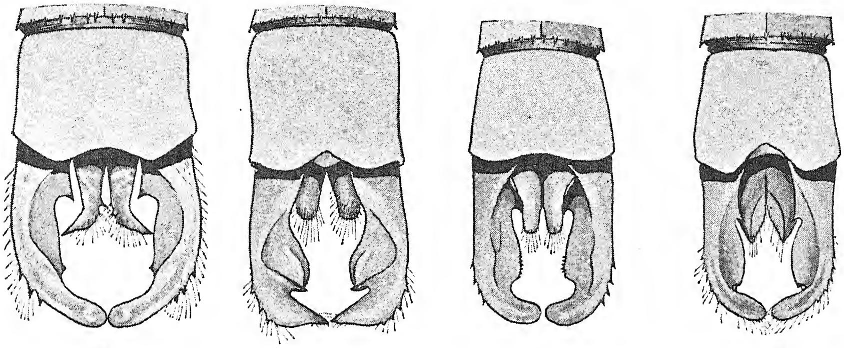
Distribution. Restricted to Kashmir and N. W. India, within Indian limits, but widely distributed throughout S. Europe, Asia Minor and Algeria. As a rule, Kashmir examples exhibit some melanism and are decidedly larger than European specimens. Mr. T. Bainbrigge Fletcher took fair numbers at Yusimarg, 7,500 ft. Kashmir during August, and I have specimens from France taken during the same month.

Lestes nodalis Selys (1891). (Pl. I. 2.)

Lestes nodalis Selys, *Odonates de Birmanie*, Ann. Mus. Civ. Genova x (xxx) pp. 496, 497 (1891) ; Laid. Rec. Ind. Mus., vol. xix, p. 151 (1920).

Male. Abdomen 30–35 mm. Hindwing 19–21 mm.

Head : labium brownish white ; labrum, bases of mandibles and cheeks pale blue but piceous in the dried state ; rest of head blackish brown but paler behind eyes ; eyes brown,



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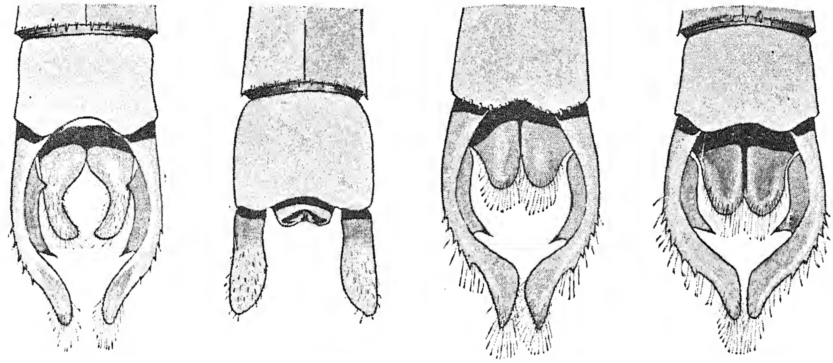

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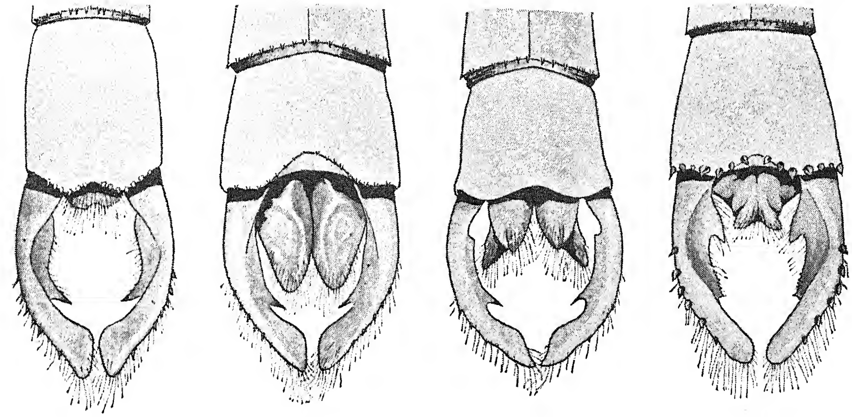

9 10 11 12

1. Dorsal view of anal appendages of *Lestes barbara* (Fabr.)
2. The same of *Lestes nodalis* Selys.
3. The same of *Lestes thoracica* Laid.
4. The same of *Lestes umbrina* Selys.
5. The same of *Platylestes platystyla* (Ramb.)
6. The same of the female appendages of *P. platystyla* (Ramb.)
7. The same of *Ceylonolestes davenporti* Ris. nov. nom.
8. The same of *Ceylonolestes gracilis gracilis* Selys.
9. The same of *Ceylonolestes cyanea* Selys.
10. The same of *Ceylonolestes pulcherrima* Fras.
11. The same of *Indolestes indica* Fras.

Prothorax olivaceous brown on dorsum, bluish laterally, two black horizontal stripes on the anterior trochanters.

Thorax dark brown on dorsum as far out as the humeral suture, and slightly overlapping this above, laterally pale blue or palest olivaceous in the dried state, a small black spot on the upper part of the postero-lateral suture and a large more conspicuous spot near the ventral border on fore part of metepimeron. Beneath olivaceous with a triangular black area just behind the hind pair of limbs.

Wings palely and evenly tinted with yellow, with dark conspicuous neuration; pterostigma bicolorous longitudinally, blackish brown at centre, yellow along costal and inner borders, elongate, tapering distad, oblique at both ends, non-braced, covering two to three cells; node thickened and showing as a conspicuous black point at costa; 13 to 15 postnodals to forewings, 9–13 in the hind.

Legs reddish yellow, the anterior pair of femora and the distal ends of the others, on the outer side, brownish black.

Abdomen light olivaceous brown peppered with black and marked with blackish brown on the dorsum of segments 1 and 2, and the apical ends of segments 3 to 6, where this colour forms a broad apical ring, enclosing on the dorsum a pale spot shaped like a barbed arrow-head with its point directed basad. On dorsum of segment 2 this spot is reproduced on a much larger scale; segments 7 and 8 dark brown; 9 and 10, especially the latter, appear to be bluish during life, but are pale olive in the dried state.

Anal appendages reddish brown, superiors about equal in length to segment 10, broad and robust, the apices abruptly rightangled inwards to meet in the middle line, the apex broad but tapering rapidly to a fine point and bordered outwardly by blackish spines; the usual inner scale-like lamina broad, occupying about the middle third of appendage and with thickened inner and outer borders, the latter projecting slightly as a fine spine. Inferior appendage short conical, coated with short coarse hairs.

Female. Abdomen 28–32 mm. Hindwing 20–21 mm.

Very similar to the male. In the single female I possess, the labrum, bases of mandibles and cheeks are dark reddish brown, as also the rest of the head; the prothorax and thorax are similar to the male; the wings are more deeply tinted a pale golden brown, the pterostigma is similar but the nervures forming its inner angle are creamy white; postnodal nervures to forewings 13–16, 9–12 in the hind, the small spines along costa are conspicuously blackish brown against the yellow costa, and the space after the pterostigma is enfumed brown; the abdomen differs by the marking on segment 2, very obscure, the apical rings on 3 to 7 present as paired spots on the subdorsum, whilst segment 9 has, on each side, a very large black spot extending for about the basal two-thirds; segment 10 appears to have been bluish during life, as also the sides of segment 2. Legs similar to the male. Anal appendages conical, pointed at apex, as long as segment 10, carneous. Vulvar scale round robust, dark brown.

Distribution. Assam, Margherita, sparingly during May and June; Burma, Palon in September; Yunnan. Probably widely and sparingly distributed throughout N. E. India and Burma; its dull colouring may render it very inconspicuous so that it may have often been overlooked. The longitudinally bicolorous pterostigma, the small black nodal point on the costa and the characteristically broad right angled anal appendages easily serve to distinguish it from other species.

Lestes umbriana Selys (1891). (Pl. I. 4.)

Lestes umbrina Selys, '*Odonates de Birmanie*', Ann. Mus. Civ. Genova x (xxx) pp. 497, 498 (1891); Laid. Rec. Ind. Mus., vol. xix, pp. 150–151 (1920).

Male. Abdomen 32 mm. Hindwing 20 mm.

Head: labium dirty yellow or pale brown; labrum, bases of mandibles and cheeks pale yellowish brown; rest of head pale reddish brown; antennæ dark brown except the two basal segments which are yellowish; eyes brown above, yellow beneath.

Prothorax and thorax dark reddish brown on dorsum, pale yellowish brown laterally without markings. Legs reddish yellow; the anterior limbs black on the outer surface, all femora and tibiæ black on the flexor surface

and the mid pair of femora with an ill-defined interrupted stripe on the outer surface.

Wings palely enfumed, hyaline; pterostigma elongate, pale brown, the outer and inner borders creamy white or palest brown, covering about 1½ cells, braced; 9–11 postnodal nervures in forewings, 9 in the hind.

Abdomen reddish brown, the dorsum darker brown but paler in some specimens; the intersegmental sutures dark brown. Anal appendages brownish yellow darkening at apices; superiors slightly longer than segment 10, coarsely spined along the outer border, forcipate, the apices curling in to meet each other and rounded at the ends, furnished on the inner border, at junction of basal and middle thirds, with a small spine, the middle third occupied with the usual scale-like expansion which terminates distad in a small inconspicuous spine. Inferior appendages conical and opposed, but the apices slightly divergent, about half the length only of the superiors.

Female. Abdomen 29-30 mm. Hindwing 21 mm.

Almost exactly similar to the male, differing mainly in sexual characters. Wings as for male with 9 to 10 postnodal nervures to forewings and 9 in the hind; head, thorax and legs as for male; abdomen darker on the dorsum from segment 3 to 7, with a pair of subdorsal subapical comma-like spots placed transversely; segments 8 to 10 and the apical half of 7 broadly blackish brown on dorsum, this colour tapering apicad on 9 and 10; segments 8 and 9 also with a large blackish brown spot on each side at the ventral borker.

Anal appendages short conical, pale yellow and with a short conical protuberance notched at its apex placed between them at the apical border of segment 10. Vulvar scale short but robust, brownish yellow, minutely serrate along its under border.

Distribution. The type comes from Burma (Bhamo), August, and is now in the Selysian collection. In this same collection is a pair from Pamizah, Bengal ?, and in the MacLachlan collection, a female from Yunnan, I possess a female from Baghwonie, Duars, Bengal, taken in June. The Indian Museum possesses specimens from Kutch, Allahabad and Panch Mahals. A specimen in the same collection is labelled as from Waltair, but during two years' residence in that district, I never once came across it, so that the label may be wrong. The species, however, appears to be widely scattered although sparsely so. Laidlaw is of opinion that it is synonymous with *L. concinna* Selys, from the Philippines and Java; after carefully comparing the description of this species with *umbrina*, I feel inclined to share his opinion. If, as he says, Selys had compared the two insects, he would probably have hesitated before describing *umbrina* as a separate species; the shape of the male anal appendages and the markings of segments 8 to 10 in the female do not differ from *L. concinna*. Superficially *L. umbrina* resembles *C. olivaceum* found in similar places, among long dried grasses. It is distinguished from other Indian species by its uniform colouring and its pterostigma with outer and inner borders paler than the body of the organ.

It is to be noted that artifects in colouring of the thorax, usually in the form of stripes on the dorsum and sides, are quite common in the dried state of these small insects, which may account for a number of errors which have crept into the Selysian descriptions.

Lestes nigriceps Fraser (1924.)

Lestes nigriceps Fras., Mem. Dept. Agricul. India, No. 8, vol. vii, Aug. (1924).

Male. Abdomen 32 mm. Hindwing 21 mm.

Head: labium, labrum, cheeks and bases of mandibles pale brown; rest of head matt black; behind eyes and head pruinosed white.

Prothorax black, largely obscured by white pruinescence.

Thorax black, marked with a narrow reddish brown (possibly blue during life) humeral stripe and a narrow irregular stripe on the mespimeron pale yellowish green. The sides near the ventral border also pale greenish yellow. On the dorsum, internal to the humeral stripe, an obscure green metallic stripe of even width similar to that seen in *L. viridula*. Legs yellow, femora and tibiæ striped longitudinally with black.

Wings hyaline; pterostigma long and narrow, about 4 times as long as

broad, pale brown; 11-12 postnodal nervures in forewing, 9 to 10 in the hind.

Abdomen brownish yellow broadly marked on dorsum with bronzed black or metallic-green as follows:—Segments 2 to 6 and the basal half of 7 metallic green or bronzed black, remaining segments black; segment 2 with the middorsal carina finely black for its basal three-fourths but widely so thereafter; on all segments the dorsal black expanding apically and confluent with a narrow black apical ring.

Anal appendages yellowish brown, superiors black at apex and base, and furnished with a robust inner basal spine followed by the usual expansion which occupies the middle third of appendage, the apical third sharply angulated inward and downward and spined along its outer border. Inferior appendages short, angulate, about half the length of superiors.

Female. Abdomen 30–32 mm. Hindwing 21–22 mm.

Somewhat similar to the male but without the extensive melanism, especially on the thorax. The black marking of head is more restricted and has a bronzed or metallic reflex; the back of head is reddish brown without pruinescence; the prothorax is pale brown with two fine dark brown lines on the middorsum and without overlying pruinescence. Thorax pale brown without black markings but with the narrow metallic green humeral stripes very conspicuous. Abdomen paler, segments 1, the sides and apical end of 9 and the whole of 10 pale brown. Anal appendages brown, conical, short, pointed at apex; vulvar scale brown, robust, finely serrate below.

Distribution. The type is a male in the B.M., from Pusa, Bihar, and apart from 2 females from the same locality, is the only specimen known. It is related to *L. viridula* by the green thoracic stripe and by the close similarity of the anal appendages, but it differs by the extreme melanism, unknown in *viridula* and by the longer *pterostigma*. I have hesitated to include this species as I have not had the opportunity of comparing it with *L. malabarica* which it closely resembles; should the two species be synonymous, *nigriceps* will have priority. The ground colour of *malabarica* is blue, but the type of *nigriceps* may have undergone colour changes from decomposition.

Lestes thoracica Laidlaw (1920) (Pl. I. 3.).

Lestes thoracica Laid., Rec. Ind. Mus., vol. xix, pp. 152–153 (1920).

Male. Abdomen 30–32 mm. Hindwing 20 mm.

Head: labium white; labrum, bases of mandibles and cheeks turquoise blue; rest of head matt black except occiput and behind head which are creamy white; eyes dark blue above, pale beneath.

Prothorax black on dorsum, creamy white laterally, marked with a large black spot on the anterior trochanter.

Thorax pale olive green with a pinkish tinting towards the middorsum; the middorsal carina finely black, as also the upper parts of the humeral and lateral sutures.

Legs yellow striped in their length with black on the outer side; tarsi black; flexor surface of femora also black.

Wings hyaline; 10-11 postnodal nervures to both fore- and hind-wings; pterostigma pale brown, framed in blackish nervures and with the outer distal end pale; braced, covering 1 to 2 cells.

Abdomen black on dorsum, pale azure blue at the sides, the dorsal black expanded subapically on segments 2 to 7, completely ringing the latter segment; segments 8 to 10 entirely black on dorsum, sides and beneath, except for a small latero-apical spot, bluish white, on both sides of the latter two segments.

Anal appendages creamy white tipped with black; superiors one and a half times the length of segment 10, forcipate, apices rounded at the ends, curling in to meet each other, coarsely spined along the outer border, furnished at junction of basal and middle thirds with a robust inner spine which is followed by the usual scale-like expansion which occupies rather more than the middle third of appendage and is finely denticulate along its inner border. Inferior appendages not quite half the length of superiors, thick at base, ungulate thereafter, rounded and furnished at apex with coarse hairs.

Female: Abdomen 28–31 mm. Hindwing 20–22 mm.

Very similar to the male.

Head: labrum, cheeks and bases of mandibles pale yellowish green, rest of

head olivaceous with a small dark brownish mark on each side of clypeus and some small spots in the ocellar space.

Prothorax and thorax olivaceous green on dorsum, paler laterally and beneath without any markings. Legs as for male, but the lateral stripes restricted to the distal ends of the femora.

Wings palely enfumed; pterostigma as for male. 10-12 postnodal nervures to fore wings, 9 to 10 in the hind.

Abdomen pale olivaceous, greenish yellow at the sides, dark markings of dorsum poorly defined; segments 2 to 7 with a pair of small spots transversely placed subapicad on dorsum; segments 8 and 10 and the apical two-thirds of 7 with the dorsum black only, broad on 7 and 8, abruptly narrowed on 9 and 10; ventral borders of 8 to 10 blackish brown.

Anal appendages very short, conical, pointed, creamy white. Vulvar scale pale robust, extending to end of abdomen, finely serrate along lower border.

Distribution. The type is a male taken at Agra, U. P., now in the Indian Museum, and there are other specimens in the same Museum from the Chilka Lake. I have a pair from Pusa, Bihar, taken in July. The species appears to be confined to Orissa, Bengal, Bihar and the U. P. It is easily recognized by the jet black head (spotted with black in the female). The female resembles that of *L. umbrina* rather closely but is distinguished by the head marked with black and by the pterostigma bordered outwardly only with pale brown.

Genus PLATYLESTES: Selys (1862). (Text fig. 1.)

Small dragonflies of the size of *Lestes* and considerably smaller than *Megalestes*, resting with wings expanded, rather dull in colouring, non-metallic; wings long and narrow, hyaline; pterostigma subquadrate, about twice as long as broad, more or less, braced; postnodal nervures moderately numerous; *ac* (postcostal nervure) situate about midway between the two antenodal nervures; *ab* meeting *ac* at border of wing; discoidal cells narrow, acute distad, differing but slightly in shape and of the same length in fore and hind-wings, that of fore-wing with the hinder border more than twice the length of costal and at least three times the length of basal, that of hind-wing only twice the length of costal but four times the length of basal; *IRiii* and *Riv+v* arising much closer to arc than to node and running parallel for some distance; *Riii* arising from *Rii* about 3 to 4 cells after the node; an oblique nervure always present between *Riii* and *IRiii*; intercalated sectors at apical end of wing similar to genus *Lestes*. Abdomen slender, longer than wings; superior anal appendages forcipate, long and attenuated, with two spines on the inner border. Female with anal appendages markedly flattened and spatulate. Genotype—*Platylestes platystyla* (Ramb.).

Venationally *Platylestes* differs scarcely from *Lestes*, although its author emphasized that the nervure *IRiii* is zigzagged in contradistinction to *Lestes* where it is not so; this character is not however at all evident in any of the three specimens mentioned below under *platstyla*, so that it may have been an aberration in the type female wing. The slight but very evident difference between the discoidal cells of fore- and hind-wings, together with the elongate attenuated anal appendages of the male point to a close relation to *Ceylonolestes* or at least to a passage from *Lestes* to that genus, which may therefore be considered as a link between the two.

Platylestes platystyla (Ramb) (1842) (Pl. I. 5 and 6 and Text fig. 2. *b.*)

Lestes platystyla Ramb. Ins., Nevrop. p. 254 (1842).

Platylestes platystyla Selys, Bull. Acad. Belg. (2) xiii, p. 338 (1862); Id *Odonates de Birmanie*, Ann. Mus. Civ. Genova, x (xxx), p. 499 (1891); Laid. Rec. Ind. Mus., vol. xix, pp. 155-157 (1920).

Platylestes platystylus Kirby, Cat. Odon. p. 164 (1890); Id. Journ. Linn. Soc. Zool. xxiv, p. 566 (1893).

Male. Abomen 33 mm. Hindwing 21 mm.

Head: labium dirty yellow; labrum, bases of mandibles and cheeks olivaceous, the former with a medio-basal dark brown spot lying in a median sulcus; rest of head violaceous brown with three small black spots at base of postclypeus and similar spots at base of antennæ and anterior to the median ocellus; behind eyes yellowish; eyes olivaceous above, paler below.

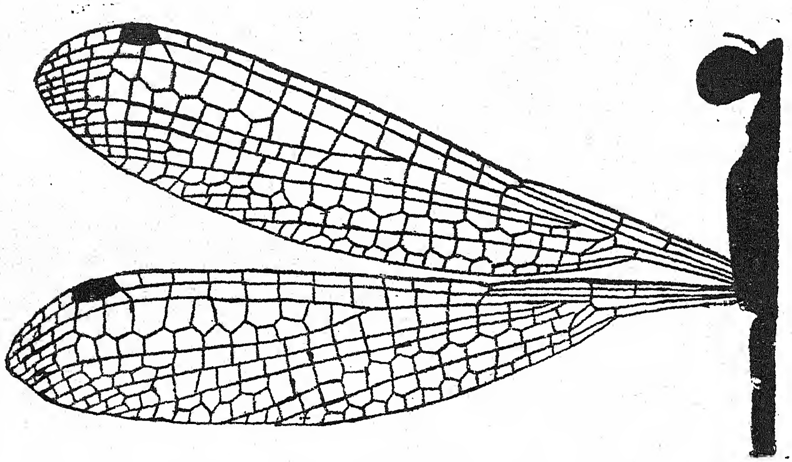

FIG. 1. Wings of *Platylestes platystyla* (Ramb.)

Prothorax and thorax palest khaki brown, paler at the sides and pruinosed white beneath, the thorax with a large number of black spots disposed as follows,—one at the anterior end of the antealar sinus, an antehumeral spot lying near the middle of the middorsal carina, 3 humeral spots, a superior, a medial and an inferior, 4 spots on the mesepimeron, one at its upper third, one over the spiracle and two at its lower part, a spot at the upper part of the postero-lateral suture, 2 spots on the ventro-lateral border and two small points closely apposed beneath thorax behind the hind limbs.

Legs pale whitish yellow with black spines, the anterior pair of tibiæ with a black outer stripe and a similar line along the extensor surface of femora.

Wings palely enfumed petiolated as far as *ac*, rather pointed at apices; pterostigma short and broad, not quite twice as long as broad, distal end nearly straight, proximal oblique and in line with the brace, costal border shorter than hinder, covering about 2 cells, dark brown with white or pale inner and outer ends; 10–11 postnodal nervures in the forewings, 9 in the hind, more rarely 8.

Abdomen olivaceous changing to warm reddish brown on the hinder segments; segments 1 to 6 with small paired subdorsal lanceolate subapical spots dark brown, these segments paler at both ends especially at the base where the ground colour tapers to a point; segments 8 to 10 with similar subapical spots, but yellow and conspicuous against the dark background. Segments 2 to 7 with black apical rings.

Anal appendages whitish, the superiors black at base, curling in at apices to meet each other in a gradual and regular curve, but the extreme apices curling a little outwards again, the outer border coarsely spined, the inner border with a thin shell-like plaque beginning from near the base as an obtuse spine and terminating about the junction of the middle and outer thirds of the appendage in an acute spine; apex furnished with a tuft of stiff hairs. The whole appendage longer and narrower than in *Lestes* and the inner expansion much narrower and resembling rather closely the type of *Ceylonolestes*. Inferior appendages about half the length, thick at base, apposed at extreme apices, then divergent and abruptly narrowed and ungulate, finally convergent at apices so as to enclose a small oval space.

Female. Abdomen 33 mm. Hindwing 23 mm.

Closely resembles the male in most respects, differing mainly in sexual characters. The black spots on the postclypeus and head are absent; labrum and bases of mandibles pale brown or yellowish; eyes brown; thorax, legs and wings similar to the male; forewings with 10 postnodal nervures, hind with only 8; pterostigma about twice as long as broad; abdomen dark brown on

dorsum, segments 8 and 9 dark ochreous, 10 golden brown clouded with dark brown near the base and along the middorsal carina, otherwise marked as for the male. Anal appendages yellow, blackish brown at base, as long as segment 10, flattened, lanceolate but inner border rather sinuous, apex obtusely pointed. Vulvar scale robust, not extending to end of abdomen, yellow clouded with brown.

Distribution. Bengal and Burma. Very few specimens of this rare and interesting species are known; the type is a female in the Selysian collection, the original Rambur type. Its description differs considerably from the above, but the differences are probably due to its poor condition and perhaps decomposition; the above description is made from a fine specimen from Hasimara, Duars, Bengal, taken by Mr. H. V. O'Donel, 7, viii, 23, a female with one anal appendage missing and now in my collection. The description of the male is from a specimen in the Indian Museum taken in Calcutta in November. There is another male in the Pusa collection from Burma and these four specimens are the only ones known. The quadrate pterostigma will at once distinguish the species from any other *Lestes*. It is possible that more than one species exists among these four, but I doubt it; it is to be hoped that more material will come to hand to settle this point.

Genus: CEYLONOLESTES, Kennedy (1920), (Text fig. 3.)

Ceylonolestes Kennedy, Ohio, Journ. Sci. vol. xxi, No. 2, p. 84 (1920).
Ceylanicolestes, Fraser, Rec. Ind. Mus., vol. xxvi, p. 487 (1924).
Lestes, Section 2, 1st Group, A, Selys, Syn. Lestes, p. 42 (1862).

Dragonflies of small stature resting with wings closed over dorsum; body non-metallic, ground colour bright azure blue; wings hyaline, untinted, petiolated as far as *ac*, *ab* meeting *ac* at hinder border of wing, *ac* situated at a level more or less distad of the midpoint between the two antenodals, discoidal cells differing in shape and size in fore- and hind wings, narrow, long and acutely pointed at the distal angle, discoidal cell of forewing with posterior border more than twice the length of costal and nearly four times the length of basal, that of hind wing with posterior border not quite twice the length of costal and five times the length of basal, *Riii* arising about 4 cells distad the node in fore wing, 3 cells distad in the hind; *IRiii* and *Riv+v* arising much closer to arc than to node, *IRiii* slightly zigzagged towards its apical end, *MA* zigzagged from level of node, oblique vein present between *Riii* and *IRiii*; pterostigma unicolorous, narrow, more than twice as long as broad, braced, outer end not oblique; intercalated sectors similar to genus *Lestes*.

Posterior lobe of prothorax simple, rounded, not lobed.

Superior anal appendages forcipate, long and attenuated, furnished along the middle third of its inner border with a narrow expansion which begins and ends in a sharp spine; inferior appendages variable, anal appendages of female conical, short.

Distribution. Ceylon, South India, Burma and Japan. Four species are confined to South India and Ceylon, one to Burma and the remaining one (*peregrinus* Ris.) to Japan. Genotype—*Ceylonolestes gracilis* (Selys).

Ceylonolestes gracilis (Hagen) (1858) (Pl. I. 8).

Lestes gracilis Hagen, *Syn. Neur. Ceylons*, No. 57, Zool. Bot. Gesellsch. Wien. (1858); Selys, Bull. Acad. Belg. (2) xiii, p. 327 (1862); Kirby, Cat. Odon, p. 163 (1890); Id. Proc. Zool. Soc. Lond, p. 206 (1891); Id. Journ. Linn. Soc. Zool. xxiv, p. 566 (1893); Laid. Rec. Ind. Mus. vol. xix, p. 158 (1920).

Lestes gracilis gracilis Ris, Suppl. Ent. No. v, pp. 13-15, Pl. I, fig. 4 (1916); Id. Spolia Zeylanica, vol. xii, p. 358 (1920).

Male. Abdomen 30-33 mm. Hindwing 20-22 mm.

Head: labium yellowish white; labrum, cheeks and bases of mandibles, pale azure blue; rest of head matt black with a cupreous reflex; eyes deep blue above paler beneath.

Prothorax blue at the sides with two thick brownish black bands on the dorsum. Thorax azure blue, paler on sides and beneath, dorsum with a thick cupreous or bronzed black band extending outwards nearly as far as the humeral suture; upper part of humeral suture black and, slightly posterior to it, a chain of three bronzed black spots; a spot on the lower part of mesepimeron just behind the trochanter and another on the upper part of the postero-

lateral suture. Beneath two small triangular blackish areas on the paired sclerites.

Legs ochreous on the extensor surfaces, black on the flexor, as also the tarsi; spines moderately long and numerous.

Wings hyaline; 10–12 postnodal nervures to forewings, 10–11 in the hind; pterostigma rather more than twice as long as broad, outer end not oblique, covering 2 cells, braced, dark reddish brown.

Abdomen azure blue, marked on dorsum with bronzed black; segment 1 with a small baso-dorsal quadrate black spot, 2 with a broad dorsal band falling short of the apical border, sometimes split up into two broad parallel stripes by the dorsal crest which is bluish, but in adults, the stripes confluent for rather more than the basal half, after which is seen a small round blue spot on the dorsal carina continuous with a fine blue line which runs into an apical blue ring; segments 3–8 with narrow blue basal rings and the middorsal carina finely yellow, rest of dorsum bronzed black; segment 9 with the dorsal black ending well before apical border as two widely divergent points, the apical portion blue, as also the whole of segment 10 except for a small basal spot of black on each side.

Anal appendages black, very long, sinuous and forcipate, curling gradually inwards until the apices meet, after which they are directed straight back in a bayonet-like angulation to end in a moderately acute point; the inner border at its middle third furnished with a scale-like dilatation which begins rather abruptly as a rounded angle and ends in a long fine spine; beneath this dilatation, at its middle, a small pointed tubercle visible only in profile, outer border near apex coarsely spined. Inferior appendages tumid, apposed, rounded at apex, about half the length of superiors which are about half as long again as segment 10.

Female. Abdomen 29–30 mm. Hindwing 23 mm.

Marked exactly as in the male but the ground colour greenish blue. In some specimens the dorsal markings of segments 2 to 5 or 6 are metallic green and the middorsal carina is finely ochreous as far as segment 7. Wings with 9–10 postnodal nervures in the fore and 9 in the hind; pterostigma similar to the male.

Anal appendages brown, paler at the base, black at apices, pointed, conical, about as long as segment 10; vulvar scale yellow or pale brown, broadly black along lower border which is not serrate.

Distribution. Ceylon hill tracts up to 6,000 ft. The type, a male in the Hagen collection, is from Rhambodda, Ceylon. I have a large series collected by Col. F. Wall, I.M.S., at Banderewela, 5,000 ft. during October.

The species is distinguished from others by the bifid dorsal marking on segment 9 and by the posthumeral chain of 3 spots. As pointed out by Dr. Ris, these spots are not mentioned in the original description.

Ceylonolestes divisa (Hagen-Selys) (1862).

Lestes divisa Hagen-Selys, Bull. Acad. Belg. (2) xiii, p. 328 (1862); Laid. Rec. Ind. Mus., vol. xix, p. 158 (1920); Laid. Spolia Zeylanica, vol. xii, pp. 358–360 (1924).

Lestes divisus, Kirby, Cat. Odon., p. 163 (1890); Id. Journ. Linn. Soc. Zool., xxiv, p. 566 (1893); Ris. Ent. Suppl. No. v, p. 13 (1916).

Male. Abdomen 33 mm. Hindwing 21 mm.

Head: labium yellow; labrum, cheeks, bases of mandibles and anteclypeus turquoise blue, rest of head bronzed black.

Prothorax similar to *gracilis*. Thorax with a broad dorsal bronzed or metallic green band tapering somewhat anteriorly and not extending as far out as the humeral suture; laterally azure blue changing to pale yellow below and beneath; marked with small black spots on the upper parts of humeral and postero-lateral sutures and a similar spot after the origin of each hinder limb.

Wings hyaline, palely enfumed; pterostigma blackish brown, about 3 times as long as broad, not dilated, outer border straight, covering 2 cells; 11 to 12 postnodal nervures to forewings.

Legs with extensor surfaces yellowish, flexor black as in *gracilis*.

Abdomen azure blue marked on dorsum broadly with bronzed black, but segments 1 and 2 metallic green as in some specimens of *gracilis*, but on segment 2 the band extending as far as apical border; segments 3 to 8 bronzed

black on dorsum, this colour tapered at the base of each segment so as to leave a basal ring of blue; segment 9 with the dark colour of dorsum tapering towards apical end but not reaching it, the apex blue; segment 10 entirely blue.

Anal appendages yellow, black at base and apex; superiors forcipate, finely spined along outer border near apex, furnished at the inner middle third with an expansion which begins gradually and is bevelled off into body of appendage, whilst, at the apical end, it tapers into a long fine spine; apex rounded, not bevelled and without any tubercle beneath. Inferior appendages half the length of the superiors, apposed at base, very tumid at origin, ungulate thereafter and with a blunt apex.

Female. Abdomen 31 mm. Hindwing 21 mm.

Very similar to the male but the ground colour greenish or pale olivaceous; markings similar to the male.

Anal appendages short conical brown, shorter than segment 10; vulvar scale short, dark brown, minutely serrate along lower border.

Distribution. The type is a male in the Hagen collection from Rhambodda, Ceylon; there is a female in the same collection. I have not seen this species which resembles *gracilis* very closely and comes from the same district. It differs by the dorsal thoracic marking tapering anteriorly, by the dorsum of thorax and the two first abdominal segments bronzed metallic green, and by the dorsal marking on segment 9 ending apicad in a point instead of bifid. The inner dilatation of the superior appendages also begins gradually instead of abruptly as in *gracilis*. For the rest it is to be remarked that specimens of *gracilis* with the thorax and first few segments of abdomen green metallic are not uncommon and the bifid character of the dorsal marking on segment 9 is often very much obscured from postmortem changes and darkening from decomposition, so that it is quite possible that the two species are synonymous. Laidlaw records *divisa* from Kandy, Ceylon, from May to July.

Ceylonolestes davenporti (Ris) nov. nom. (Pl. I. 7.)

Lestes gracilis birmanus Ris nec Selys, Suppl. Ent. No. v, pp. 13, 14 (1916); Laid. Rec. Ind. Mus, vol. xix, p. 158 (1920).

Male. Abdomen 30–33 mm. Hindwing 19–23 mm.

Head: labium pale yellow; labrum, bases of mandibles, cheeks and clypeus turquoise blue, postclypeus with its outer ends broadly black, only the central part blue; head above bronzed or cupreous black; occiput yellow at the median parts of its hinder border.

Prothorax black on dorsum, broadly blue laterally and with a median dorsal stripe on the middle lobe tapering anteriorly; anterior lobe blue with a small black spot posteriorly on its middorsum; posterior lobe with a fine middorsal blue line which broadens anteriorly to become confluent with the middorsal blue of middle lobe.

Thorax black on dorsum with a cupreous reflex as far back as nearly to middle of mesepimeron, the border of the black being broadly angulate or crenulate; a narrow antehumeral blue stripe bordering the humeral suture, incomplete above where it slightly overlaps the suture; laterally azure blue with a small linear spot on mesepimeron near its upper part, and a second black spot on upper part of postero-lateral suture. Beneath pale blue or yellow clouded with brown, two oblique spots on the paired sclerites just behind the hinder pair of limbs and a pair of tiny pyriform black spots at centre.

Legs bluish green on whole of extensor surfaces from femora to tarsi, black on flexor.

Wings hyaline; pterostigma blackish or dark reddish brown, the terminations of the bordering nervures posteriorly white, covering nearly two cells, braced, nearly three times as long as broad; 10–13 postnodal nervures in forewings, 10-11 in the hind.

Abdomen azure blue laterally, broadly black on dorsum with a green metallic reflex as far as segment 5 then with cupreous reflex to the end of segment 8; the greater part of 9 and the whole of segment 10 azure blue save for a narrow mediobasal black line and a lateral black spot on each side of segment 10; segment 1 black on dorsum from base to apex; segment 2 marked as for *divisa*, the metallic band extending from base to apex but tapering to a point at apex of segment to become confluent with a narrow apical black ring,

middorsal carina finely ochreous expanding into a small blue spot just apicad of the middle of segment; segments 3 to 5 with the middorsal carina finely ochreous, with narrow blue basal rings and with the dorsal black expanded subapicad on each segment; segments 7 and 8 entirely black save for the ventral borders of 8 narrowly; segment 9 with a broad triangular black spot on each side narrowly confluent over dorsum at base, tapering apicad but not nearly reaching end of segment.

Anal appendages blue, apices and inner border black or entirely black in old specimens, the apices thickly coated with white hairs. Superiors forcipate, long attenuated and curved gently towards each other to meet at apices which are thickened and with the point directed straight back, coarsely spined along outer border near apex and with the usual expansion on the inner border at the middle third beginning as an abrupt rounded angle and ending in a long acute spine; beneath the appendages, near the middle of the expansion, a small tubercle seen in profile. Inferior appendages half the length of superiors, which are about half as long again as segment 10, broad, rounded, apposed at bases; apices rounded, black.

Female. Abdomen 31 mm. Hindwing 24 mm.

Closely similar to the male, the markings only differing on segments 8 and 9 where the sides are broadly blue; segment 9 has the whole of dorsum cupreous black, whilst 10 has two large triangular black spots confluent or not over dorsum as on segment 9 in the male.

Wings hyaline, palely enfumed in very old specimens; 11 postnodal nervures in forewings, 9 in the hind; pterostigma reddish brown.

Anal appendages greenish blue, about as long as segment 10, conical pointed: vulvar scale yellow, brownly black along border which is very minutely serrate.

Distribution. Western Ghats south of the Palghat Gap from 4,000 ft. to 6,000 ft. I have specimens from the Palni plateau and from the Mudis, Annaimallai Hills, the latter being decidedly smaller than the Palni specimens which are taken at a greater altitude. Mr. T. Bainbrigge Fletcher and Col. Frere took this species in some plenty in the Palnis from May to July, but I found it by no means common in the Mudis where it required much searching for. Here it frequented only one locality amongst scrub, near a river, resting almost vertically and with closed wings. I was much struck with how blue it appeared as compared with dried specimens, or even with *C. pulcherrima* in the living state. It is distinguished easily from *gracilis* and *divisa* by the blue antehumeral stripe. From *C. birmanus* Selys, which Dr. Ris thinks the species to be synonymous with, the differentiation is far more difficult, but as the Selysian description is very brief, I have no doubt differences will easily be found. All species of the genus are so local in their distribution that I am unable to reconcile *birmanus* with occurring in Continental India and in so far removed a district as the Western Ghats. It is thus, for geographical reasons only, that I consider them to be two distinct species.

Ceylonolestes birmanus (Selys) (1891).

Lestes divisa nec Selys, *Odonotes de Birmanie*, Ann. Mus. civ. Genov. x (xxx), p. 495 (1891).

Lestes gracilis birmanus Ris, nec Selys, Suppl. Ent. No. v., pp. 13–14 (1916); Laid. Rec. Ind. Mus, vol. xix, p. 158 (1920).

Male. Abdomen 30 mm. Hindwing 21 mm.

The Selysian description of a single male taken at Puepoli, Burma, in June is as follows: 'I am not certain that this single male is *divisa* Hagen, which I do not possess and which I know only from a short description which I published in 1862 in Syn Lestes, No. 40. In the Puepoli specimen there is immediately after the humeral suture on the sides of the thorax, a moderately broad band black of which the outer border has three angles *en echelon* somewhat like that seen in *L. colensonis* of New Zealand. This black band is not mentioned in the description of *divisa* and if not a simple omission, the species of Fea will be new and I propose for it the name of *Lestes birmanus*, distinguished from *L. divisa*, Ceylon, by the front of thorax black with a blue antehumeral band on each side.'

Thus the description, if such a brief one may be so called, fits *C. davenporti* exactly, but even so, such is the extremely local character of all species of *Ceylonolestes* that the vast distance separating Burma from the Western

Ghats of India seems to me an insuperable difficulty in regarding the two insects as conspecific. Further material from Burma is needed to settle this point and it is to be hoped that some of our entomological members in Burma will assist us in this respect.

Ceylonolestes pulcherrima (Fraser) (1924). (Pl. I, 10 and text-fig. 2.*a*.)

Ceylanicolestes pulcherrima Fras., Rec. Ind. Mus., vol xxvi, pp. 487–489. Pl. xxvi, fig. 6 (1924).

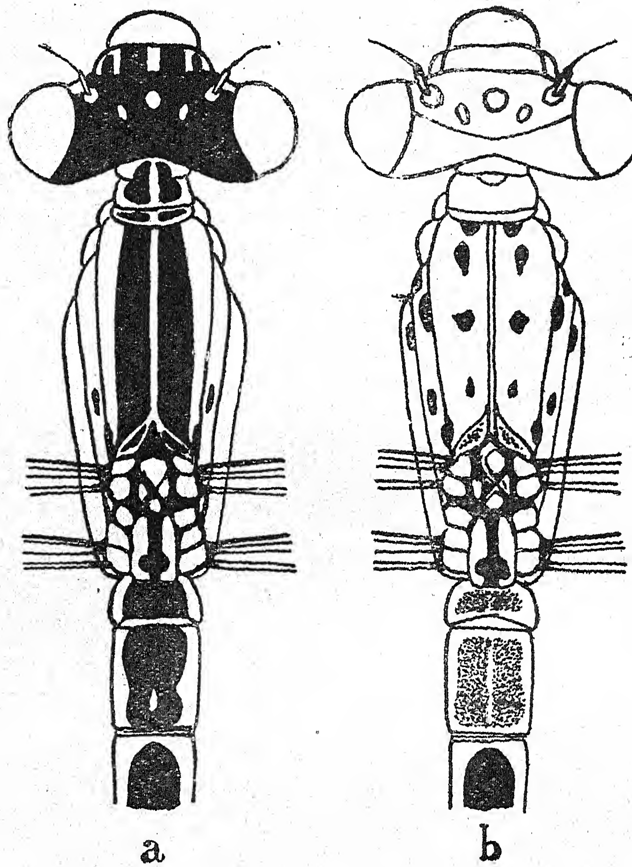

FIG. 2. *a*. Head, thorax and first two abdominal segments of *Ceylonolestes pulcherrima* (Fras.). *b*. The same of *Platylestes platystyla* (Ramb.)

Male. Abdomen 34 mm. Hindwing 21 mm.

Head: labium white; labrum, bases of mandibles, cheeks and anteclypeus turquoise blue: postclypeus darker blue marked with two small black points, rest of head black with a dull green metallic reflex; eyes deep blue above, turquoise blue in front, greenish yellow beneath.

Prothorax blue laterally, brownish above, marked with two dark green metallic parallel stripes.

Thorax turquoise blue laterally, the dorsum narrowly dark metallic green, the middorsal carina and margins of antealar sinus finely blue. Laterally marked with a large black spot behind the upper part of the first lateral suture

and a smaller one behind its middle; the upper ends of sutures black. Beneath dirty white with two large black spots converging at the anterior part of the unpaired sclerites, and a larger blackish brown spot on either side posterior to them.

Legs brown, flexor surfaces black.

Wings hyaline, postnodal nervures to forewings 12, in the hind 11; pterostigma blackish brown with paler borders, about three times as long as broad, inner side oblique, outer straight.

Abdomen azure blue marked with black as follows:—segment 1 with a small basal black spot; segment 2 with a narrow apical ring and a broad dorsal band shaped like the head of a thistle extending from base to apex; segments 3 to 7 with dorsal bands not quite extending to base of segments where they leave a small blue ring, apically expanding and then contracting again to become confluent with narrow apical black rings; segment 8 all black except the apical suture which is blue; segment 9 with the basal third black, the remainder blue, as is whole of segment 10.

Anal appendages. Superiors blue at base turning to white and finally brown at apices which are tipped with white hairs, narrow, forcipate, apices curling gradually in until they meet, outer border near apices coarsely spined, furnished on the inner border with a very narrow expansion which begins to emerge from appendage gradually, not abruptly as in other species (except *divisa*) and ends in a long fine spine. Inferior appendages about half the length of superiors which are about half as long again as segment 10, very tumid, apposed except at extreme apices, broadly conical.

Female. Abdomen 33 mm. Hindwing 24 mm.

Head: eyes olivaceous green above, pale greenish yellow beneath; labrum very pale blue, rest of head as in the male.

Prothorax and thorax pale olivaceous brown with a somewhat violaceous tint, the middorsal carina and margins of antealar sinus finely reddish brown, black markings exactly similar to the male.

Legs pale yellowish brown, flexor surfaces black.

Wings similar but in old adults evenly tinted with pale brown; 11–12 postnodal nervures to forewings, 10 in the hind; pterostigma as for the male.

Abdomen violaceous brown changing to reddish brown on the distal segments, marked with black as follows:—segment 1 with a basal black dorsal spot; segment 2 with a broad dorsal band split by the reddish brown dorsal carina for its apical two-thirds, the band unevenly expanded towards the basal border of segment, abruptly expanded towards the apical; segments 3 to 5 as for the male; segments 5 and 7 with blue basal rings; segments 6 and 7 with the dorsal band rather ill-defined towards the base of segments, whilst segments 8 to 10 are uniform dark brown.

Anal appendages as long as segment 10, conical, pointed, pale blue; vulvar scale robust, dark brown, very minutely serrate along free border.

Distribution. Found only in Coorg but in many swampy localities, at about 2,500 ft. to 3,500 ft. in that area. Usually found in jungly retreats, a belt of dense scrub or trees surrounding a small pond is the favourite situation. In such a place they may be found perched on the tips of twigs at any height up to about fifteen feet from the ground. The species is essentially arboreal, males being found in the above described swampy retreats, females in the surrounding jungle not far from the breeding places.

Ceylonolestes cyanea (Selys) (1862). (Pl. I. 9 and text fig. 3.)

Lestes cyanea Selys, Bull. Acad. Belg. (2) xiii, p. 335 (1862); Laid. Rec. Ind. Mus., vol. xix, pp. 158–161 (1920).

Lestes cyaneus Kirby, Cat. Odom., p. 163 (1890).

Indolestes helena Fras., Mem. Dept. Agric. Pusa, India, vol. vii, pp. 60-61, Pl. vii, fig. 1. (1922).

Indolestes veronica Fras., Ibid., vol. viii, No. 8, p. 85 (1924).

Male. Abdomen 32-36 mm. Hindwing 21-24 mm.

Head: labium palest brown or dirty white; labrum, cheeks and bases of mandibles turquoise blue; rest of head matt black with a coppery reflex behind the bases of antennæ; eyes dark blue above, paler below.

Prothorax black on dorsum with a blue middorsal stripe, narrow on the posterior lobe, broadening abruptly on the median lobe. Laterally pale blue traversed by a thick longitudinal black stripe.

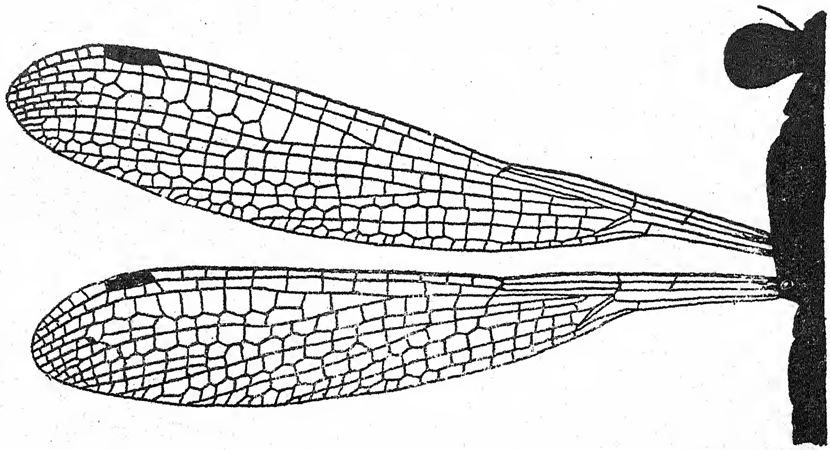

FIG. 3. Wings of *Ceylonolestes cyanea* (Selys.)

Thorax with the dorsum and sides as far posterior as the middle of mesepimeron black with a violet or coppery reflex, the borders of antealar sinus and the middorsal carina finely mapped out in pale greenish blue, a narrow antehumeral stripe gradually broadening below limited posteriorly by the humeral suture and incomplete above but continued posterior to the suture by a narrow dagger-shaped stripe, the upper portion of which may be cut off to form an isolated small spot. Laterally blue, the margin where it meets the black anteriorly being irregularly zigzagged or angulated, the black extending back above and gradually tapering away on the metepimeron and descending for a short distance along the postero-lateral suture. Beneath pale brown with two triangular areas dark brown.

Legs with the flexor surfaces of femora and tibiæ and the tarsi black, the extensor surfaces of femora and tibiæ bright ochreous.

Wings hyaline, palely enfumed in very old adults only; 13–14 postnodal nervures to forewings, 11–12 in the hind; pterostigma rather squared at both ends, especially distad, braced but the brace occasionally proximad of the pterostigma, about $3\frac{1}{2}$ times as long as broad, black or blackish brown, covering 3 or more cells; *Riii* arising 3-4 cells distad of the node; posterior border of discoidal cell in the forewing about 4 times as long as the basal, and about 5 times as long in the hind; *ac* slightly nearer the level of the distal antenodal nervure

Abdomen azure blue marked with black as follows:—segment 1 with the base black, the outer borders of this marking prolonged apicad as a narrow black line as far as the apical border; segment 2 with a narrow subdorsal black stripe on each side which become confluent at a point over the dorsum at apical border of segment and send up a subapical pointed prolongation over dorsum to nearly enclose a small subapical spot of the ground colour; segments 3 to 6 with apical paired wedge-shaped spots confluent finely over the dorsum at apical border but tapering basad, the middorsal carina finely blue between them, these spots gradually lengthening from segment 3 to 6, on the latter of which they extend for about halfway to base; segment 7 nearly entirely black, this leaving only a narrow basal ring and the whole length of the middorsal carina finely blue; segments 8 and 9 all black except the middorsal carina which is finely blue; segment 10 entirely blue but some black spines along its apical border.

Anal appendages blue changing to ferruginous and finally blackish brown at extreme apex, about half as long again as segment 10, forcipate, curving gradually in to meet at apices which are directed straight back posterior wards (the two appendages resembling the arms and hands of a man in the act of

diving), furnished near the base with a narrow expansion occupying the middle third of appendage, arising insensibly from the body of appendage and not as a blunt spine and terminating in a long thin acutely pointed spine directed towards apex of appendage; apex obtusely pointed and directed a little downwards and slightly expanded as seen in profile, tipped with fine white hairs, outer border rather coarsely spined. Inferior appendages rudimentary, tumid, rounded at apices, closely apposed, about one-fourth the length of superiors.

Female. Abdomen 33–36 mm. Hindwing 24–28 mm.

Head, thorax and legs marked exactly as in the male but the ground colour pale greenish blue; wings in elderly adult specimens more deeply enfumed especially towards the apices; 12–14 postnodal nervures to forewings, 11–12 in the hind; pterostigma dark reddish brown, the inner and outer borders finely bright ochreous. Abdomen with the black markings more extensive as follows:—segment 1 with whole of dorsum black save for a small middorsal spot of blue; segment 2 with the subdorsal black stripes thicker and confluent at base as well as apical border of segment, the included ground colour narrow at apex and base but broadening at the middle three-fifths; segments 3 to 6 with the apical spots prolonged basad as narrow black stripes almost as far as the base where they leave a broad basal blue ring confluent with a broad middorsal blue stripe which extends as far as apex of segments; segment 7 similar to the male but the basal blue ring broader; segment 8 with the dorsum all black save for the basal half of middorsal carina which is finely blue; segment 9 entirely black and segment 10 all blue save for a minute middorsal basal triangle of black.

Anal appendages pale ochreous or carneous, about as long as segment 10, conical, pointed; vulvar scale blackish brown, yellow along attached border, lower margin not serrate.

Distribution. Bengal and hills of the Northern Punjab from 3,500 to 9,000 ft. during May and June. I possess specimens from Simla and Darjeeling, and at the latter place, I found larvæ breeding in swift cold mountain streams at Ghoom. A thousand feet lower down I found the imago on the wing at the same date. This species is one of the most beautiful Lestids known and is easily distinguished from all others by its abdominal markings. It is much larger than all other species of genus *Ceylonolestes* and differs from them also by the short spines on its legs. It appears to be more closely allied to genus *Austrolestes* and should perhaps be placed in a genus of its own.

After due consideration I have come to the conclusion that my species *I. helena* and *veronica* are merely varieties of this species, the difference in ground colour and markings being due probably to their age. I have come to this conclusion after perusing Dr. Laidlaw's discussion on some teneral specimens of *cyanea* which greatly puzzled him as did the specimens of *helena* and *veronica* the author, and which Dr. Laidlaw grouped in his second category 'B'. The anal appendages of *I. helena* are similar to those of *cyanea* and the difference in the markings may well be explained through decomposition. The specimens of *I. veronica* are the largest known specimens of *cyanea* if indeed they are synonymous with that species. The type of *C. cyanea* is in the Selysian collection, *veronica* and *helena* in the Br. Mus. collection.

Genus INDOLESTES Fraser (1922).

Indolestes Fraser, Mem. Dept. Agric. Pusa, India, vol. vii, p. 57 (1922).

Dragonflies of small stature resting with wings closed over dorsum; body non-metallic or this restricted to some small spots on the basal abdominal segments, ground colour pale brown; wings hyaline, always more or less tinted evenly pale brown, very narrow and with pointed apices, petiolated as far as *ac*; *ac* meets *ab* at hinder border of wing; postnodal nervures numerous; discoidal cells differing in shape and size in fore and hind-wings, very narrow and elongate and very acutely pointed at distal angle, discoidal cell of forewing with posterior border 3 times as long as basal and twice the length of costal, that of hindwing with posterior border not quite double the length of costal and 6 times as long as basal; *Riii* arising $3\frac{1}{2}$ cells distad of node in forewing, $2\frac{1}{2}$ cells in the hind (5 cells in both wings of *I. buddha* (Laid)); *IRiii* and *Riv + v* arising much nearer arc than node; *IRiii* slightly angulated towards its apical end, *MA* zigzagged from level of node; oblique vein present between *Riii* and *IRiii*; pterostigma bicolorous, narrow, 3 times as long as broad, outer end not oblique; intercalated sectors similar to genus *Lestes*.

Posterior-lobe of prothorax simple, rounded, not lobed.

Superior anal appendages narrow, elongate, forcipate, furnished at the middle third of inner border with a narrow expansion which begins with an obtuse spine and ends with a long acute one; inferior appendages short, tumid; anal appendages of female conical, short.

Distribution. N. E. India and Burma.

This genus is very similar to *Ceylonolestes* and so nearly related that I have been unable to find any very satisfactory characters by which to differentiate them. The points which have influenced me in bestowing separate generic rank are the bright blue ground colour of all species of *Ceylonolestes* contrasting so strikingly with the dull pale browns of *Indolestes*. The enfumed tinted wings and the bicolorous pterostigma of the latter are other striking points; the discoidal cell, especially that of hindwing, is narrower in *Indolestes* and strongly suggests that there is an evolutionary tendency for that structure to disappear entirely by a fusion of the costal and hinder borders. The straight distal border of the pterostigma and the simple posterior lobe of the prothorax separate it from genus *Sympycna* which it greatly resembles otherwise.

Indolestes indica Fraser (1922). (Pl. I. 11 and text-fig. 4. *a*.)

Indolestes indica Fras., Mem. Dept. Agricult. Pusa, India, vol. vii, pp. 58-59 (1922).

Lestes sp. Laid., Rec. Ind. Mus., vol. xix, pp. 161-162 (1920).

Indolestes buddha Laid. nov. nom. Fras. l. c. pp. 57 and 59 (1922).

Male. Abdomen 30 mm. Hindwing 19 mm.

Head: labium palest brown; labrum brown, paler at the sides; base of mandibles, cheeks, the basal three segments of antennæ except the apex of the third and two small triangular spots just posterior to and to the outer side of the hinder ocelli pale yellowish brown; rest of head black with a cupreous sheen or dull blackish brown; middle of occipital border yellowish; eye bluish grey with five dark brown bars running from above out and forwards.

Prothorax dark reddish, brown on dorsum with the middorsum of middle lobe paler brown and the sides pale brown.

Thorax black on dorsum with a cupreous reflex, this colour forming a band extending from middorsal carina outwards to about halfway to humeral suture, the outer border sending out processes somewhat like those seen in *L. præmorsa*, one above extending to the humeral suture, another at the middle of band which falls far short of the suture, the border of the band thus exhibiting two deep concavities; the upper prolongation enclosing a tiny point of the ground colour; laterally very pale brown marked with linear black spots at the upper ends of the lateral sutures and by two or three small black or green metallic spots just posterior to the humeral suture. Beneath whitish brown marked with two oblique streaks of blackish brown.

Legs yellow or ochreous on the extensor surface, black on the flexor; spines moderately numerous and short, black.

Wings hyaline, neuration dark brown, membrane evenly enfumed with pale brown; pterostigma pale brown with the distal end bright yellow. proximal end oblique, distal nearly straight; 11 to 13 postnodal nervures to forewings, 11 to 12 in the hind.

Abdomen pale reddish brown or ochreous marked with metallic green and black as follows,—segment 1 with a basal lunar spot, followed immediately by, or actually confluent with, a small triangular subdorsal spot on each side metallic green; segment 2 with a broad basal spot on dorsum shaped like the ace of clubs but with the middle lobe tapered apicad for rather more than half the length of segment, immediately following this a broad subdorsal comma-like spot on each side metallic green or cupreous black (in some specimens, the narrow apical end of the basal spot is squared and each corner becomes confluent with the apical spots to enclose a bright yellow oval dorsal spot); segments 3 to 6 with paired apical and sub-basal spots, the former pyriform with the thick end towards base of segment and separated narrowly by the ochreous middorsal carina, the apical spots triangular and confluent over dorsum where they are narrowly separated from fine black apical rings; segments 7 and 8 wholely black on dorsum, but on 8 the black not quite reaching base of segment and bisected finely by the ochreous middorsal carina for nearly its whole length; segment 10 palest brown, unmarked.

Anal appendages almost white; superiors very long, about half as long again as segment 10, forcipate, curved evenly and gradually towards each other

until the apices meet, dilatation at inner third barely perceptible but beginning as an angle and ending as a long sharp spine, apex sinuous and tapered to a point, its outer border finely spined. Inferior appendages not half the length of superiors, bases formed by two broad cones, from the outer side of apex of which springs a short thick tapered ungulate process, coated with hairs.

Female. Abdomen 23·5 to 28·5 mm. Hindwing 19 to 21 mm.

Closely similar to the male, the ground colour and markings not differing except on the abdomen. Wings more deeply enfumed; 13 postnodal nervures to forewings, 12 in the hind, pterostigma as in the male; segment 1 with the subdorsal spots quadrate and always confluent with the basal; segment 2 with the spots confluent and forming a dumb-bell-shaped marking not quite extending to apex of segment, the middorsal carina in the apical half of the marking ochreous expanding into a small fusiform spot near the middle of segment (the combined comma-like spots are together broader than the basal spot, although shown in the reverse order in Laidlaw's figure, but they may be subject to some variation); segments 3 to 5 similar to the male but on 5 the basal pair of spots are very small and may be quite absent; segment 6 with only a diffuse, poorly defined brown apical ring; segment 7 with the apical pair of spots continued basad as a diffuse broad brown stripe and with the middorsal carina pale brown; segment 8 with two broad subdorsal stripes separated by the ochreous middorsal carina; segment 9 with a broad subdorsal reddish brown stripe on each side.

Anal appendages shorter than segment 10, pale yellow, flattened, slightly but distinctly notched at apex; vulvar scale palest brown or yellow, not extending to end of abdomen, minutely serrate along lower border.

Distribution. Known only from Assam. The type of Laidlaw's *Lestes sp.* is a female from Cherrapunji, Assam, 4,400 ft., 8. X. 14, in the Indian Museum collection, No. 8204/20. The author's type is a male in the British Museum, from Shillong, Assam, 6,000 ft., June 20. Mr. T. Bainbrigge Fletcher took this species in June and again throughout October and found them resting with closed wings on bushes beside a stream, but others were found far from water in a pine tope at the top of a hill. Since the author first described the species, more material has come to hand and from the variability in the size and markings of the insects, it is clear that it is conspecific with Dr. Laidlaw's *Lestes sp.* The latter was described from a subadult specimen in which the markings were not fully developed and of which the size is decidedly smaller than the Shillong specimens Distinguished from *I. bilineata* (Selys) and *I. assamica* sp. nov., by the abdominal markings and presence of posthumeral thoracic markings.

Indolestes bilineata (Selys) (1891).

Lestes bilineata Selys, *Odonates de Birmanie*, Ann. Mus. Civ. Genova, x (xxxx) p. 498 (1891); Laid. Rec. Ind. Mus., vol. xix, p. 163 (1920).

Female. Abdomen 30 mm. Hindwing 20 mm. (Male unknown.)

Head: labium palest brown; labrum, cheeks and bases of mandibles, and clypeus and frons as far as origin of antennæ olivaceous; rest of head and behind eyes bronzed black except the space between the ocelli and occiput which is pale brown; eyes brown.

Prothorax pale brown with a small darkish spot on each side the middle lobe.

Thorax pale reddish brown on dorsum passing to whitish brown laterally and beneath; the middorsum narrowly black bisected by the ochreous middorsal carina; laterally a short dark spot at the upper ends of the lateral sutures.

Legs pale brown, the anterior pair of femora with a black stripe on the outer side; spines long, black.

Wings hyaline, palely enfumed brown, with brown reticulation; pterostigma greyish brown between black nervures, short, thick, only twice as long as broad, distal end straight, proximal oblique, covering 1½ to 2 cells; 10 to 12 postnodal nervures to forewings.

Abdomen pinkish brown marked with bronzed green as follows:—segment 1 with a middorsal spot; segment 2 with a broad dorsal stripe finely bisected by the ochreous middorsal carina; segments 3 to 6 with a poorly defined dorsal bronzed fascia ending in a darker subapical ring; segment 7 with the dorsum

bronzed metallic except at both ends which are pale ; segments 8 to 10 brown ; beneath black.

Anal appendages as long as segment 10, palest brown, sublanceolate, pointed ; vulvar scale brown, not quite extending to end of abdomen, finely serrate beneath.

Distribution. Burma only. The type is a female in the Selysian collection from Palon, Burma, taken in September. Only three specimens are known, the third being also a female in the British Museum. It is evidently closely allied to *I. indica* from which it is distinguished by the totally different markings of abdomen. From *I. assamica* sp. nov., it is distinguished by the relatively short pterostigma, by the different character of the anal appendages and by the markings of anterior pair of femora, etc.

Indolestes assamica sp. nov.

Female. Abdomen 32 mm. Hindwing 21 mm. (Male unknown.)

Head : labium palest brown, almost white ; labrum, bases of mandibles, cheeks, clypeus and anterior border of frons pale yellow, the postclypeus with a black point at each end and two larger submedian black spots ; the three basal joints of antennæ yellow as also a tiny point behind each posterior ocellus and the whole of the occiput from eye to eye ; rest of head matt black ; eyes olivaceous brown.

Prothorax pale brown with a pair of parallel black subdorsal stripes expanding on the posterior lobe, narrow on the middle lobe where they are very narrowly separated.

Thorax pale brown, the middorsum matt black as far as midway from middorsal carina to humeral suture, the outer border of the band quite straight, the carina finely ochreous ; laterally a small black spot on the upper part of the humeral suture and a similar but smaller on the upper part of the postero-lateral suture. Beneath unmarked. Legs pale straw coloured with black spines, quite unmarked.

Wings evenly enfumed pale brown, reticulation darker brown ; pterostigma long and narrow, inner and outer ends oblique, reddish brown between dark brown nervures, covering 2 to 3 cells ; discoidal cells as for genus ; 12 to 13 postnodal nervures to forewings, 10 in the hind.

Abdomen pale brown or yellowish brown marked with dark brown, black and reddish brown as follows :—segment 1 with a quadrate dorsal spot extending from end to end of segment ; segment 2 with a narrow black band, its ends slightly expanded, extending from base to apex of segment, the middorsal carina finely dark ochreous ; segments 3 to 7 similar to 2 but the bands tapered abruptly at each end of segment ; segments 8 to 10 reddish brown on dorsum.

Anal appendages yellow, conical, pointed, as long as segment 10 ; vulvar scale robust, extending to end of abdomen, yellow.

Distribution. Confined to Assam so far as known. The type is a female in the author's collection and is the only specimen known ; the specimen has been labelled '*Lestes bilineata* Selys ? ' since 1918, but after a careful re-examination and contrast with the description of that species, the following insuperable differences were noted :—The pterostigma is nearly four times as long as broad instead of 'nearly quadrate' as in *bilineata*, as noted by Selys, it is also oblique at both ends, whereas *bilineata* has the outer margin straight. The legs have no markings and the vulvar scale extends to the end of abdomen.

From *I. indica* it is easily distinguished by the outer border of the middorsal marking of thorax quite straight, whereas it is deeply indented in *I. indica* ; the totally different character of the abdominal markings and the shape and size of the pterostigma are additional distinguishing characters.

Genus : SYMPYCNA Charpentier (1840).

Sympycna Charp., Lib. Eur., p. 19 (1840) ; Selys, Rev. Odon., p. 161 (1850); Id. Bull. Acad. Belg. (2) xiii, p. 336 (1862) ; Laid. Rec. Ind. Mus., vol. xix, pp. 145-146 (1920) ; Kirby, Cat. Odon., p. 163 (1890).

Sympecma Selys, Mon. Lib. Eur. p. 144 (1840).

Dragonflies of small stature very similar to *Indolestes* and resting like them with wings closed over dorsum ; ground colour pale brown with metallic markings on head, thorax and abdomen ; wings hyaline tinted with pale brown, very narrow and with pointed apices, petiolated as far as *ac*, *ac* meets *ab* at hinder border of wing ; postnodal nervures fairly numerous ; discoidal

cells differing in shape and size in fore- and hind-wings, very narrow and elongate and very acute at distal angle, discoidal cell of forewing with posterior border at least 3 times as long as basal and twice the length of costal, that of hindwing with posterior border 5 or 6 times the length of basal and slightly less than twice the length of costal; *Riii* arising 5 to 4 cells after the node in forewing and hindwing respectively; *IRiii* and *Riv + v* arising much nearer arc than to node; *IRiii* not or scarcely angulated; *MA* zigzagged from level of node; oblique nervure present between *Riii* and *IRiii*: pterostigma uni- or bi-colorous, three or four times as long as broad, inner and *outer ends oblique*; intercalated sectors as for *Lestes*.

Posterior lobe of prothorax *trilobed*, the middle lobe being much more prominent than the lateral.

Superior anal appendages narrow, elongate, forcipate, furnished at the middle third of the inner border with a narrow dilatation which begins with a very robust tooth or spine and ends in an obtuse angulation; inferior appendages short, tumid; anal appendages of female sublanceolate, pointed, longer than segment 10; vulvar scale robust, extending only to middle of segment 10.

Distribution. Europe, Asia Minor, North Africa, Central Asia (Mesopotamia, Persia, Kashmir). The genus is closely allied to *Indolestes* but is easily recognized by the long pterostigma *oblique at both* ends and by the *trilobate character of the posterior lobe of the prothorax*. Only one species or subspecies found within Indian limits, viz. from Kashmir and Quetta. Genotype,—*S. fusca* Lind.

Sympycna paedisca annulata Selys (1887). (Pl. I. 12 and text fig. 4. *b*.)

Sympycna paedisca annulata Selys, Ann. Soc Ent. Belg. xxxi, p. 43 (1887); Morton, nec *fusca*, Trans, Ent. Soc. London, p. 308 (1907); Id. Ent Month. Mag. Ser. 3, vol. v, pp. 145-146 (1919); Bartenef, Ann. Mus. Zool. Acad. Impl. Sci., St. Pet. t. xvii, (1912).

Sympycna paedisca paedisca Laid., Rec. Ind. Mus., vol. xix, p. 163 (1920.)

Male. Abdomen 30 mm. Hindwing 21 mm.

Head: labium whitish; labrum, bases of mandibles and cheeks pale olivaceous brown; rest of head slightly darker warmer brown marked with blackish brown and metallic green as follows:—postclypeus with a small spot at each end and a large submedian quadrate blackish brown spot at each side of middle line; frons with a sinuous linear stripe of metallic green curling outwards on each side and narrowly interrupted by the middle line, a hour-glass shaped spot on the outer side of each posterior ocellus, the whole of the ocellar space, the occiput and a foliate spot behind each eye, which is confluent with it, all brilliant metallic green; eyes brown above, yellow beneath.

Prothorax pale brown, its middle lobe with a large dorsal spot on each side, its posterior lobe metallic emerald green and border finely yellowish.

Thorax palest brown, its dorsum broadly metallic green nearly as far out as the humeral suture, the outer border of this marking irregular and usually with a hooked-like prolongation about its middle; antealar sinus metallic green within its borders, which latter as well as the middorsal carina are finely ochreous. Laterally a narrow, very irregular and somewhat zigzagged bright metallic green stripe running from the antero-lateral suture above obliquely down to lower end of humeral suture.

Wings hyaline, enfumed pale brown, venation brownish yellow; node thickened; pterostigma yellow to dark brown with bordering nervures yellow, oblique at both ends, covering 2 cells; 14 postnodal nervures to forewings, 12 in the hind.

Legs yellow, femora with a chain of small dark brown spots; numerous and moderately long dark spines.

Abdomen pale brown or coloured like dry grass marked with metallic green as follows:—segment 1 with a pair of triangular apical spots barely confluent over dorsum; segment 2 with a pair of parallel stripes narrowly separated by the pale yellow middorsal carina, each shaped like a note of exclamation mark, the basal half pyriform, the apical rounded, apposed surfaces flat; segments 3 to 7 similar, the stripes being longer and narrower and separated by the yellow middorsal carina and falling a little short of the base; segments 8 and 9 with stripes approximating to that on segment 2 but broader and clumsier in build

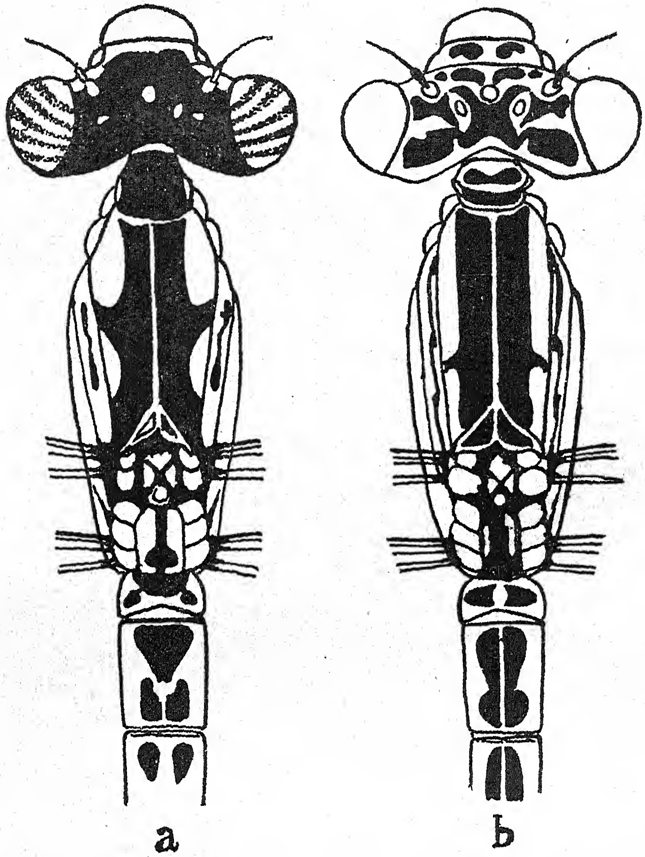

FIG. 4. *a.* Head, thorax and first two abdominal segments of *Indolestes indica* Fras.
b. The same of *Sympycna paedisca annulata* Selys.

and with a cupreous reflex; segment 10 with the dorsum narrowly dark cupreous brown, deeply notched at apex and bordered with black spines.

Anal appendages yellowish white, bordered near apices with black spines; superiors narrow, forcipate, apices curling gradually in to meet each other, furnished at the middle third of inner border with a dilatation which begins with a very large and robust tooth and ends in an angulation tipped with a minute black spine; apices rounded, tipped with white hairs, appendages about one and a half times as long as segment 10; inferiors rudimentary, about one-third the length of superiors, conical, closely apposed.

Female. Abdomen 30 mm. Hindwing 21 mm.

Exactly similar to the male but some variation of the middorsal stripe of thorax which may have the outer border quite straight or with a markedly conspicuous medial prolongation; the wavy posthumeral stripe often interrupted once or twice. Femora of first two pairs of legs with a black outer stripe or chain of spots; segment 10 with a dorsal stripe tapering apicad but not reaching the apex.

Anal appendages very large and robust, cylindrical, pointed, longer than segment 10, pale buff in colour; vulvar scale short, extending only to middle of segment 10, lower border minutely serrated with black teeth. Pterostigma palest brown, covering 1½ to 2 cells.

Distribution. Kashmir and N. W. India within our limits. The specimen described by Morton from Quetta as *S. fusca* is really this subspecies of *paedisca.* Laidlaw mentions specimens from the Jhelum Valley, Kashmir, 5,000 ft. and I have seen a number of specimens collected by Mr. T. Bainbrigge Fletcher at Sirinagar, Kashmir, in July. The author found *S. paedisca annulata* moderately common at Kerna at the junction of the Tigris and Euphrates in November, 1914, and Morton mentions specimens collected higher up the river at Amarah. So far as known, it extends from Asia Minor to Kashmir through Mesopotamia and Persia and the N. W. Frontier Provinces. Mesopotamian specimens have the wavy posthumeral stripe split up into three widely separated spots ; the prothorax has a median spot on the anterior lobe, a pair of angulated spots on the middle lobe and the whole middle section of the posterior lobe dark cupreous metallic ; pterostigma bright ochreous. The shape of the pterostigma and the posterior lobe of prothorax will serve to distinguish this species from any of *Indolestes.*

(*To be continued.*)

A TOUR IN FURTHER KASHMIR

BY

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(*With two plates*)

A summer trip to the Highlands of Kashmir to study bird life in the less-frequented parts, more especially at high altitudes, was our object. From the following account the reader will be able to judge how far it was achieved. Our party, to start with, was three strong consisting of—

Real Admiral Hubert Lynes, R.N., Hugh Whistler (Indian Police, Retired) and the writer.

We left Marseilles on March 24th in the P. and O. *Rawalpindi* in which we were luxuriously accommodated in three separate single-berthed cabins.

Our passage through the Mediterranean was devoid of much interest, and we reached Port Said early on the 28th. As we had four or five hours here we decided to visit the Sewage Farm, a well-known bird locality about three miles out of the town. Here we found plenty of bird life, the spring migration being apparently in full swing.

The native population take a very heavy toll from these little birds, largely songsters, in passage, catching vast numbers in small spring traps which are so constructed as to kill the bird usually instantaneously by a blow near the base of the skull. We saw large bags of such birds, including many wagtails and pipits—about to be carried in to the town where they are sold in the bazaar for eating at about a penny each.

We purchased several as specimens and they were duly skinned on board ship afterwards.

The different kinds of birds seen at the Sewage Farm included :—

White Wagtails.
Black-headed Yellow Wagtails.
Grey-headed Yellow Wagtails.
Lesser Whitethroats.
Bonelli's Willow-Warbler.
Redstart.
Wryneck.
Rufous-throated Pipit.
Tree-Pipit.
Streaked Wren-Warblers.
House-Sparrow.

April 1. We arrived at Aden but were not allowed ashore on account of plague. It was pleasantly cool with a N.E. wind blowing. We had to content ourselves by feeding the Gulls (chiefly Hemprich's Sooty Gulls, Herring Gulls and Black-headed Gulls) and kites, with bits of biscuit.

April 6. We arrived at Bombay about midnight and got ashore at 6 a.m. It was decidedly hot and we were glad to be off by the new extra-rapid Peshawar Express, which landed us at Rawalpindi in about thirty-nine hours. We had intended stopping a night here, but found to our surprise and disappointment that no accommodation could be had anywhere, so we quickly made arrangements for a car to take us through to Srinagar in Kashmir (200 miles) and a lorry for our kit.

We managed to get through about half way to Garhi that night and the following day, April 9, we reached Srinagar and occupied three comfortable single rooms in Nedou's new Hotel (annex). The next ten days were spent in Srinagar completing the arrangements for our trip, engaging servants and transport, hiring tents and camp furniture, and laying in provisions for four months.

During our halt in Srinagar the weather was decidedly cool—often cold—and we had some heavy rain storms. Spring was well on, and some of the summer migrants had already commenced breeding, e.g., *Saxicola torquata indica* and *Emberiza stewarti,* both building on the Takht. Other birds observed on the Takht were *Anthus trivialis harringtonii* and *A. sordidus jerdoni, Monticola solitaria pandoo, Emberiza cia strachey; Sylvia althæa, Phylloscopus iornatus humii, Pericrocotus brevirostris* and *Bubo bengalensis.* One of the latter was sitting in an empty nest hole on the rocky hill face and another was found killed, possibly by a Bonelli's Eagle.

April 19. Having got all our servants and kit on to two house-boats—a larger one for ourselves and a smaller for the kitchen and servants—we started off down stream in the Jhelum river, our objective bring Bandipur on the north side of the Wular lake and distant some thirty miles.

The river was in full flood, so manual propulsion was scarcely necessary. We reached Sumbul bridge, a little over half way, after dark and were afraid to attempt passing under the bridge in the dark, the river being in such high flood, we might have found insufficient clearance for our boats, so we tied up for the night. The weather was most depressing, cold, windy and wet.

Our spirits revived with the morning light and we ran under the bridge in safety—only a few inches to spare! and reached the Wular Lake about midday.

Owing to the unusually high floods the lake had become a very extensive sheet of water probably not less than 100 square miles whereas it is usually very much smaller, especially in the late autumn.

As we entered the lake, which had flooded out extensive areas of cultivation, we saw numbers of rats, apparently the ordinary large brown field variety, swimming for their lives. Many were drowning and still more had already succumbed—a few were striking out bravely for the land, miles away, which they could never reach. A few more fortunate ones had found a stick or a weed tuft to rest on. We also saw near by several apparently, well-fed specimens of Pallas's Fishing-Eagle which were evidently already gorged to repletion with these rats. We also saw a pair of Ospreys over the lake but they were not interested in the rats.

Numbers of Garganey Teal on migration, a party of Godwits and a Glossy Ibis were other interesting birds seen on the lake.

After three hours paddling we reached Bandipur, on the north side of the lake, where our kit was put on shore and loaded up on to some thirty ponies. Three miles up the road brought us to the Sunarwáni Rest House by the Gilgit Road, a fairly good centre for birds, with a river close at hand.

Passing through the large village of Bandipur, we noticed a large heronry on the tops of two or three large *Chenar* trees. Some of the birds appeared to be incubating and others building. The nests were inaccessible without a climbing outfit. The birds were the common Grey Heron.

April 21. Explored the Madmati river for a few miles. Saw Brown Dippers with young strong on wing and Plumbeous Redstarts with eggs. White-capped Redstarts and Grey Wagtails were not yet breeding.

April 22. Went out in a boat on the Wular lake. Saw large flocks of gulls which were rather wary. We however ultimately succeeded in securing three nice specimens which proved to be Brown-headed Gulls (*Larus brunneicephalus*). These birds winter along the Indian coast and breed at high altitudes in Tibet by the Salt lakes, e.g., Tso Kar and Tso Moriri lakes in Rupshu at 15,000′. Those we saw were evidently on their way to their breeding grounds.

April 23. Bandipur to Olus, seven miles along the northern shore of the Wular lake. On the march we saw Paradise Fly-catchers and Wrynecks, doubtless recently arrived, Goldfinches, King Crows (*D. longicatudatus*), Stewart's Bunting and many Rufous-backed Shrikes.

The camp was a pretty one among willow and mulberry trees and near the village. We noticed a fine large Tawny Owl (*Strix aluco biddulphi*) sitting all day in a willow near our tents. His mate was probably sitting on eggs in a neighbouring hollow tree but we failed to find her.

We secured several specimens of the Gold-fronted Finch (*Metoponia pusilla*) which were in fair sized flocks on the dry hillside, studded with low thorny scrub and weed growth.

April 24. A march of eight miles, first up valley to a pass at 8,000′ and then down again to about 6,000′ in the well-known Lolab Valley. Snow was still lying in patches near the pass. Here among the silver firs, spruce and blue pine we noticed parties of Warblers (*Phylloscopus*) and Black-crested Tits (two species) also Nuthatches (*Sitta leucopsis*) and *S. kashmiriensis,* and several large green woodpeckers—doubtless *Picus squamatus,* though we failed to secure one. Himalayan Pied Woodpeckers (*Dendrocopus himalayensis*) were also in evidence—and we heard several Collared Pigmy Owlets (*Glaucidium brodiei*) calling.

While resting in the open near the pass we observed a pair of Golden Eagle soaring at a great height overhead. The shape of this splendid eagle is unmistakable on the wing. We also saw a Buzzard at close quarters.

As we descended into the Lolab valley we passed through a forest

of deodars, a tree which is absent from a large portion of Kashmir but is common in the Lolab and adjacent Kishanganga valley, and also in Bhadarwah.

April 25 to 28. We spent four days in the Lolab valley exploring the country round Makám (our camp).

We saw the usual birds of the Kashmir valley including our first Cuckoo and Indian Oriole.

Tickell's Ouzel were singing both morning and evening.

One of the commonest birds in the Lolab is the Slaty-headed Paroquet (*Psittacula schisticeps*). We found them mostly in small flocks feeding on the flowers (petals) of the apple trees and on the catkins of the walnut trees. This bird is not at all common in the valley of Kashmir. We also shot a Long-eared Owl (*Asio otus*), being mobbed by a pair of Jays (*G. lanceolatus*). This Jay I had not previously seen in Kashmir. It is one of the truly Himalayan birds which is largely confined to the southern face of the Pir Panjal and the Chenab Valley. Lastly we heard on several occasions the monotonous and characteristic call of a Scops Owl. We failed to obtain or even to see this owl, but the call is identical with that of *Scops sunia,* a bird I know well in the sal forest of the Sub-Himalayan tract.

On April 27, Admiral Lynes received bad news from home and decided he must give up the expedition and return at once to England. This was a great blow and disappointment to all of us. The Admiral would not hear of our returning home with him, and insisted on our carrying out the programme as arranged, and the following day we sadly bid him farewell as he left in a car for Srinagar.

April 29. A Besra Sparrow-Hawk (*Accipiter virgatus affins*) was secured which proved to be laying eggs, but we failed to find the nest.

April 30. Return march to Olus. On the way we found the nest of *Sitta kashmiriensis* in a hole in a deodar tree which had been closed up with clay masonry leaving a hole of 1″ in diameter only. The nest was lined with thin bits of yew bark and was empty.

Near by we noticed a pair of Buzzards (*B. desertorum*) on the top of a big deodar tree, and a search revealed their nest near the top of another deodar. As it was a difficult tree to climb and the nest might not have been new, we left it unexamined.

May 1. Olus to Sunarwáni.

On the march we saw Bee Eaters (*M. apiaster*). These birds have apparently just arrived. We also fired at and wounded, a chiffchaff which flew away heavily and was quickly seized by a shrike (*L. erythronotus*) which we shot with the bird in its beak and eventually obtained both. The chiffchaff was *P. collybita sindianus*. The next two days we halted and reduced our stores, etc., which had been arranged for a party of three.

We saw and obtained a fair number of birds here including *Alseonax ruficaudus, Cyornis tricolor, Horornis pallidus, Acanthopneuste occipitalis* and *Sylvia althæa.*

Wrynecks, Hoopes and Tickell's Ouzels were common. We also

saw numbers of swifts of two kinds, viz., a large Spine-tail Swift and also *Cypselus apus*—flying high and probably moving up to their breeding grounds. We failed to secure specimens.

We also noticed a small party of four black storks resting on a hill top and evidently also on migration.

May 5. We marched nine miles south along the eastern margin of the Wular lake, as far as Ajas, a pretty camp close to the lake, under mulberry trees. There were many Whiskered Terns and Pheasant-tailed Jacanas over and on the lake and we secured specimens. We also saw *Dicrurus longicaudatus* and W. secured a *Motacilla citreola* which is a passage migrant in Kashmir. Rock Horned Owls (*Bubo bengalensis*) and Scavenger Vultures (*Neophron percnopterus*) were both breeding on the steep rocky precipices north of our camp.

May 6. Ajas to Manasbal. Seven miles. Saw three male Paradise Flycatchers near our camp, of which two were white and one rufous. Reed Warblers (*Acrocephalus stentoreus brunnescens*) were already very noisy in the reed beds in the lake.

May 7. Our camp at Manasbal was under gigantic Chenar trees (*Platanus orientalis*) full of Jackdaws mostly with nests and eggs in their hollows.

The view over the Manasbal lake was very fine. We climbed to the top of a neighbouring isolated mountain, Ahateng 6,200′ where we found Skylarks, Jerdon's Pipit, Stonechats, Stewart's Buntings and the Chukor—all breeding and with eggs, except the Skylarks.

In the village below we found several swallows' nests with eggs. The nests were all in the dwelling rooms of villagers, who do not disturb the birds. The nests and eggs resemble those in Europe. The Kashmir swallow is *Hirundo rustica rustica.*

May 8. Manasbal to Ganderbal. The shortest road across country is only six miles. We made a detour in order to explore the Krahom swamp, an extensive bog near which, in previous years, I had found Harrington's Paddy-field Warbler in large numbers. We were, however, apparently rather too early for this bird as we only saw two and secured one.

Our camp at Ganderbal was alongside the Sind river full of icy water straight down from the glaciers. In the eve: we went up stream and saw a good many *Did-he-do-it* Plovers and also little Ringed Plovers both breeding on the islands.

One solitary stranger was also seen—a Plover, which I had never seen before. It was as large as a *Did-he-do-it,* but quite differently marked. It was being attacked by a pair of little Ringed Plovers which had freshly hatched young. It was seen again by both of us in the evening and although we failed to secure it, we satisfied ourselves that it was undoubtedly a Grey-headed Lapwing (*Microsarcops cinereus*). This would be an addition to the list of Kashmir birds.

On the islands in the Sind river we found three nests of the Common Sandpiper containing four nearly fresh eggs in each. The eggs were laid in depressions in the sandy ground under low spreading clematis. A *Did-he-do-it's* nest on the same island also contained four eggs.

May 11. Took a tonga to Tula Mull village and thence made a very thorough re-examination of the Krahom jhil.

In the drier area we shot two Grasshopper Warblers (*Locustella nævia straminea*) and one Blyth's Reed-Warbler (*Acrocephalus dumetorum*), and one *Cypselus apus.* Later on assisted by a line of coolies we explored a quaking bog, where it was necessary to walk very circumspectly. Here we put up a number of rails and shot :—

Eastern Ruddy Crake (*Amaurornis fuscus bakeri*) ...	4
Eastern Baillon's Crake (*Porzana pusilla pusilla*) ...	2
Spotted Crake (*Porzana maruetta*)	1

We saw no water rails, a bird which we had hoped to find in the swamp.

May 12. Before leaving Ganderbal we had a day on the mountain side, which rises up rather abruptly from the valley level (5,000′) up to about 11,000′. On the lower slopes we found Stewart's Bunting, Jerdon's Pipit, the Eastern Stonechat and Hume's Lesser Whitethroat all breeding and with eggs. We also saw and secured specimens of the Grey-headed Bunting (*E. fucata*), which were also about to breed.

May 13. Marched about ten miles up the Sind valley to Kangan. The weather was perfect. We secured a nest with four fresh eggs of the Jungle Crow (*Corvus coronoides intermedius*) near the top of a blue pine. These birds are common up to the limits of tree growth. Near our camp we noticed a pair of King Crows (*Dicrurus leucophæus longicaudatus*) which gave a very perfect imitation of the call of the Kestrel. They evidently were also about to breed as they vigorously attacked any crow which approached the large walnut tree in which they had taken up their quarters.

May 14. Kangan to Gund. Fifteen miles. A delightfully cold morning : our path followed the river. On the march we saw several European Rollers and secured a pair. These birds are of course migrating, spending the summer months and breeding in Kashmir. We also shot a pair of Yellow-vented Bulbuls (*Molpastes leucogenys*) which are common throughout the Kashmir main and side valleys up to about 6,000′. We also shot a young Brown Dipper (*Cinclus pallasii*) in spotted plumage. These birds are evidently very early breeders.

May 15. Gund to Gaggan Gir. Seven miles. Our path still follows the valley, and we are now at 7,000′ altitude among the Firs and Pines. The scenery is much grander and the river is beginning to assume the characters of a torrent. The Indian Blue Chat (*Larvivora brunnea*) was common in the mixed deciduous forest on the hillside above Gund. The cock has a loud, clear but short song. The birds are extremely shy and we secured three specimens only and that with some difficulty.

We also shot three specimens of the Himalayan Pied Woodpecker (*Dryobates himalayensis*)—also examples of the Pale Bush-Warbler (*Horornis pallidus*) and of Tytler's Willow-Warbler (*Phylloscopus tytleri*). A pair of Fire-caps (*Cephalopyrus flammiceps*) were also seen, doubtless about to breed—and two specimens of *Cuculus saturatus* were both seen and heard calling—the Himalayan Cuckoo is not very common in Kashmir.

May 16. Gaggan Gir to Sonamarg. Seven miles. The ascent has become a good deal steeper, the river being a veritable torrent and even a cascade in places and the valley a rocky defile passing between very steep rocky precipices thousands of feet above.

Avalanches had done much damage sweeping away bits of fir forest and piling up the debris of smashed timber in huge masses alongside the river. In three separate places the river was bridged by substantial snow bridges a most unusual state of affairs below Sonamarg so late in the season.

When we arrived at the Tajwaz camping ground, altitude 9,000′, near Sonamarg we experienced considerable difficulty in finding a spot clear of snow and fit to camp on. Here we halted five days during which time the snow rapidly disappeared in the hot sun and the ground all around our tents became a veritable cloth of gold from the flowers of a pretty little yellow crocus-like flower. This is probably the origin of the name 'Sonamarg' (Golden meadow).

The view from our tents looking straight on to a row of peaks 16,000′ high with a glacier in the foreground only two miles distant, was very grand.

We found birds fairly numerous in spite of the snowy conditions.

The Larger-spotted Nutcracker (*Nucifraga multipunctata*) was fairly common and we came across a family of fully-fledged young, probably at least two months old.

Other birds seen in and around Sonamarg were Nuthatches (*S. leucopsis kashmiriensis*), Crested Black Tits (*Lophophanes melanolophus* and *rufonuchalis*), Tree-Creepers (*Certhia himalayana* and *familiaris hodgsoni*), the Black and Yellow Grossbeak, Mistle-Thrush, Red-flanked Bush-Robin, Red-browed Finch, Orange Bull-finch, Stolicka's Mountain-Finch, Skylarks, the Eastern Meadow-Bunting, the Rufous-tailed Flycatcher, Pipits (*A. roseatus* and *trivialis harringtonii*), also Alpine Choughs, Jungle-Crows, and Scully's Wood-Owl.

A few of these were already commencing to breed and before we left we secured eggs of *Ianthia rufilata, Lophophanes rufonuchalis, Lophophanes melanolophus* and *Certhia familiaris hodgsoni.*

May 22. Sonamarg to Baltal. Ten miles. The path still follows the river which is now again slow flowing, and the rise to Baltal is only a few hundred feet. Red-billed Choughs were seen on the march, and we secured also a nest of the Jungle-Crow with four hard set eggs.

We found the out-buildings of the Baltal rest-house had been completely wrecked by an avalanche and the bridge over the stream giving access to the camping ground had also been carried away.

The valley above Baltal was very full of snow and from about two miles up the river disappeared altogether under beds of snow and snowfield. W. found the nest of Scully's Wood-Owl (*Syrnium biddulphi*) in a large hole in a birch tree only six feet from the ground containing two slightly-set eggs and portions of the shell of a third egg lay on the ground outside the hole.

A White-beasted Dipper (*Cinclus kashmiriensis*) was shot by the stream below our camp.

May 23. Baltal to Matayan. Fifteen miles. As we were to cross

the Zoji La Pass to-day we had to make an early start to avoid risk of avalanches. We got off with our retainers and our kit loaded on twenty-five ponies at 5.30 a.m. Owing to the heavy winter snowfall the pass was not yet open for pony traffic and instead of going up by the road we had to follow the much steeper and shorter route up the snow-filled gully. An icy wind blew down the valley. We reached the pass after a climb of about 2,000 feet, at 8 a.m. and were glad of the sun. In ordinary years the route from this point down to Matayan is easy, being a gentle decline over snow. On this occasion, however, things were quite different, and our troubles began after leaving the Pass. Owing to the exceptionally heavy winter snowfall our track lay over a series of avalanches which made the going slow and difficult for men and almost impossible for laden ponies, which frequently sank up to their girths in snow and had to be unloaded and lifted out. Moreover the track lay often along steep snow slopes overhanging a rushing icy torrent and we were extremely fortunate in not losing any of our animals or kit. We reached the hut at Matayan at 3.30, cold and tired, and were glad of the welcome shelter.

We had seen very few birds *en route*. Chiffchaffs, Bluethroats and Sandpipers were on their breeding grounds which were mostly under snow. Some deluded bird, possibly a bunting, had started building a nest in a hole in a snow cornice! We shot a cock Ruby-throat, two Horned Larks, a Skylark, two Tree-Pipits and two Hodgson's Pipits. We were surprised to find the Tree-Pipits on the bare open hillsides, there being no tree growth after leaving the Zoji La above Pandras.

May 24. Matyan to Dras. Fourteen miles. A dull, cold morning —a pair of Tibetan Ravens greeted us outside the hut. The march was over snow as far as Pandras.

At Pandras we came on a small plantation of poplars and willows —the first trees we had seen since the Zoji La. Here we found our first Magpie's nest—which contained a single fresh egg.

The Ladakh Magpie (*Pica pica bactriana*) is very similar to the English Magpie in note and appearance, but is not found in forest localities. It frequents the stony sandy wastes of Ladakh and Baltistan, keeping in the vicinity of villages where it finds food and also willow trees in which it builds its nests. A pair of these magpies have for years built their nest in a hole under the roof and above the front door of the Dak Bungalow at Dras! An unusual site for this species.

Below Pandras we saw many Short-toed Larks (*Calandrella acutirostris*) and a single *Ibidorhynchus*.

At Dras there was practically no snow. The altitude of the village is 10,000′, and there is a Post and Telegraph office as well as a Meteorological station. The minimum temperatures recorded at this station in winter are lower than any others in the Indian region, and not infrequently temperatures of 30° below zero Fahrenheit are experienced early in January.

We halted five days at Dras which gave promise of good things in the bird line, but as a matter of fact we found we were really about a month too early for most breeding birds.

By far the commonest birds around Dras at this time of the year are Horned Larks. There are also a considerable number of Short-toed Larks. The former are in flocks feeding in the corn fields on the young germinating grain. A little later as the snow melts from 11,000′ to 13,000′ they will retire to these higher altitudes to breed. All the Horned Larks we saw were *Otocorys alpestris longirostris*. Magpies were fairly common and we found several nests in willow trees at a height of from 10′ to 20′ with five or six eggs generally fresh. The Eastern Carrion Crow (*Corvus corone orientalis*) was also not rare, being found in the vicinity of villages. A pair had a nest with three eggs in a poplar tree in our camping ground at Dras. The birds were most confiding and did not display any of the cunning or devilry so usual to members of the Crow tribe.

Both species of Dipper were found here, the Brown and the White-breasted but whereas the former had bred some months ago the latter had not apparently commenced building.

Other birds seen in the vicinity were Swifts (*Cypselus apus pekinensis*), Martins (*Delichon urbica*) and Crag-Martins (*Ptyonoprogne rupestris*). Redstarts were also common, and mostly building but we obtained one nest in a hole in a wall containing four fresh eggs. Kestrels were quite common and a few Ravens and Choughs were seen, the latter chiefly at higher elevations. A pair of Ravens frequented the camping ground, close to our tents. They were not very shy and they watched our bird-skinning operations and carried off the bodies of the birds we had skinned and thrown away. A Lämmergeyer also found our camp interesting and after soaring around for a little, alighted a short distance away. The House Sparrow (*Passer domesticus parkini*) is exceedingly common but they had not yet commenced to lay.

May 30. Dras to Tashgam. Fifteen miles. Our path lay down the Treaty road which follows the Dras river. Soon after leaving Dras we saw a kestrel swoop down into a party of larks one of which it secured and carried off in its claws. The lark was, I think, a *Calandrella.* The Kestrel in Ladakh and Baltistan seems to be much more addicted to attacking birds than the European bird, as we saw it seize and carry off birds on two other occasions the victim being in one case a Bluethroat and on the other apparently Stoliczka's Mountain Finch.

The march down the valley was very hot indeed about midday and we were glad to reach the welcome shade of our camping ground which was in an irrigated walled in plantation of willows and poplars. A pair of Carrion Crows had a nest with young in a tree close to our tents but the parent birds were curiously shy about returning to the nest. A pair of Hobbys (*Falco subbuteo*) also frequented the willow plantation in which they evidently intended to breed later.

A Golden Eagle was seen to-day soaring at a considerable height. Also a number of vultures and a raven collected round the carcase of a horse. The vultures varied considerably in colour some being brownish, others nearly white—different stages no doubt of *Gyps himalayanus.*

May 31. Tashgam to Karkitchu. Fourteen miles. Still following

the Dras river down to our camp at 9,000, on the way we passed a large patch of cultivation with patches of scrub, briars, etc., and here we found numbers of Bluethroats, some in full song. We noticed cocks with a red spot, a white spot and unspotted blue, probably all one species, showing how variable is the throat colouration in this species. *Phylloscopus indicus* was not uncommon on the dry rocky slopes with small bushes near our camp. We also saw the Sind Willow-Warbler (*Phylloscopus collybitus sindianus*) and the Eastern Meadow Bunting (*Emberiza cia stracheyi*) building. Currant bushes of three kinds as well as juniper bushes were very common on the hillsides round our camp.

June 1. Karkitchu to Kargil. Seven miles. A short march down to the junction of the Dras and Suru rivers and then up the latter two miles to the large village of Kargil. This is rather an important place being near the junction of two trade routes, viz. that from Yarkhand *via* Leh and another from Skardu.

There is much valuable cultivation and an excellent system of irrigation channels, with plenty of tree growth (all planted and dependent on irrigation). There is a Post and Telegraph office, a dispensary and many small native shops. Here we halted four days.

On the march from Karkitchu we saw for the first time several Chats (*Œnanthe pleschanka*).

The valley around Kargil is very beautiful at this time of the year with its poplars, willows and apricot trees in delicate new green leaf, and the crops, chiefly barley, about a span high. Between the fields are masses of beautiful blue irises. The altitude of Kargil is about 8,900′ and was the lowest place visited by us beyond the Zoji La. The maximum and minimum temperatures at this time of the year were 80° and 50° respectively.

The common birds of Kargil met with by us were :—

Carrion-Crows, Magpies, Kestrels, Skylarks, Short-toed Larks, Bluethroats, Redstarts, Hume's Lesser Whitethroat, Chiffchaffs, Common Rose-Finches, Gold-fronted Finches, the Large-billed Bush-Warbler and a few Hoopoes and Orioles.

The Kestrel, of which we found two nests with three and four fresh eggs respectively proved to be *Falco tinnunculus tinnunculus.* The nests were in holes in sandstone cliffs, one overhanging the river.

The larks were not yet breeding but we found two Bluethroats' nests in grass at the base of small thorn bushes with four and five nearly fresh eggs.

Whitethroats were mostly building but one nest with four fresh eggs was found in a briar. Nest and eggs much resemble those of the European Lesser Whitethroat. Several Chiffchaff nests were found chiefly in low thorny bushes, containing generally four eggs which are white-spotted and speckled with chestnut and *not chocolate* markings as in the English bird. The Ladakh Chiffchaff proves to be *Phylloscopus collybita sindianus.* We obtained the nest of a Hoopoe (*Upupa epops epops*) in a hole in a willow tree in the village containing eight fresh eggs. Most of our time in Kargil was however spent in watching a Wheatear (*Œnanthe pleschanka*) which was not uncommon on the neighbouring sandy, rocky plateaux

above the river. Each pair occupies an area of about half a square mile of the driest and most desolate country imaginable. The cock is a dapper little fellow in his pure black and white plumage. The hen is pale sandy brown and very inconspicuous in the sandy wastes she frequents. The cock has a bright clear song sometimes uttered from the top of a rock, and at others on the wing while flying round in circles at a considerable height. After singing on the wing the bird will sometimes execute a remarkable dive to earth carried out at lightning speed. It was some time before we discovered the nest of this chat, as the birds are wary and do not readily give away the position of the nest. Eventually however we found a good many nests under construction, which about ten days later contained four or five eggs each. Nests were situated in holes under rocks or stones,. usually invisible from outside, and were composed of dry grass or weed stems, with a dense, warm lining of wool and hair. The eggs pale blue, spotted pinkish.

June 6. Kargil to Paskyum. Six miles. Our route led over a sandy plateau frequented only by Siberian Chats and a few Short-toed Larks. Our camp at about 9,300′ was alongside the Wakka stream, a tributary of the Suru river.

There was plenty of dense willow and thorn growth near our camp which was full of Bluethroats and Chiffchaffs. We watched a pair of Chiffchaffs building their nest near the top of a pollard willow, fifteen feet from the ground. This is a most unusual situation for the nest. We saw the Grey-backed Shrike (*Lanius tephronotus*) for the first time here. Also a Lämmergeyer was noted.

On the hill above our camp we shot a Desert Chat (*Œnanthe deserti oreophila*) a bird chiefly found at much greater altitudes. We also found a Skylark's (*Alauda gulgula guttata*) nest with four fresh eggs in a lucerne field and a dessicated adult Horned-Lark which appeared to be *O. elwesi,* as well a nest of *Œnanthe pleschanka* in a pile of stones which contained five fresh eggs.

The Olivaceous Tree Warbler (*Phylloscopus indicus*) was along the Wakka stream. Nests of the Bluethroat, Grey-backed Shrike (two eggs) and Chiffchaff were found on the march.

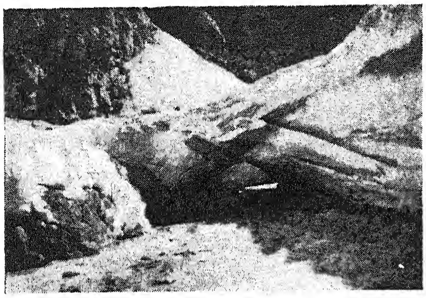
The Olivaceous Tree Warbler (*Phylloscopus indicus*) was observed in a side valley 1,500′ above our camp.

June 9. Lotsam to Maulbekh. Nine miles. Following the Wakka stream up a rather narrow valley we reached an open cultivated area at 10,750′ at Maulbekh. This is our first experience of Buddhist country with its chortens and mane walls.

We found the vicinity of the stream near Maulbekh an excellent place for several birds, chiefly Bluethroats, Pied Wagtails, Chiff-chaffs, Skylarks and Common Sandpipers all of which were breeding. The Pied Wagtails (*Motacilla alba hodgsoni*) built well-concealed nests under stones on stony islands in mid stream. Sandpipers had eggs on the same islands which were mostly near hatching.

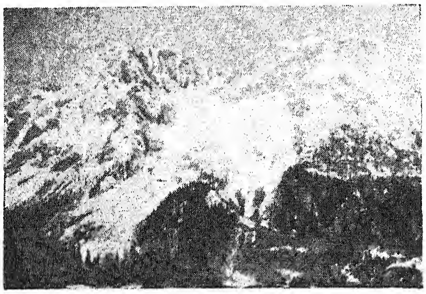
A pretty little yellow flowering plant, a *Corydalis* was found growing out of the interstices of dry rocks. This has proved to be a new species, *C. osmastonii.*

June 11. Maulbekh to Bod Kharbu. Sixteen miles. Making an early start we passed literally hundreds of Blue Rock Pigeons

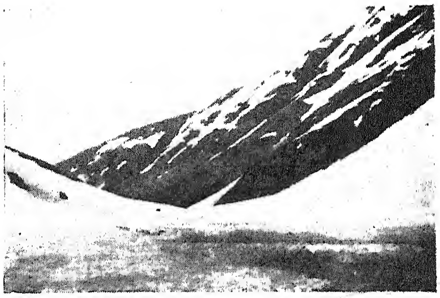


1.—Snow bridge on the Sind River.

2.—Track of an avalanche, Sind Valley.

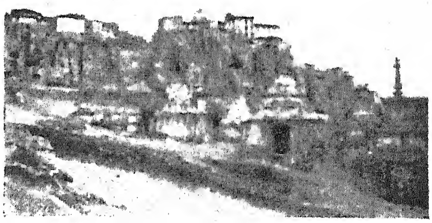


3.—Glacier opposite our camp at Sonamerg.

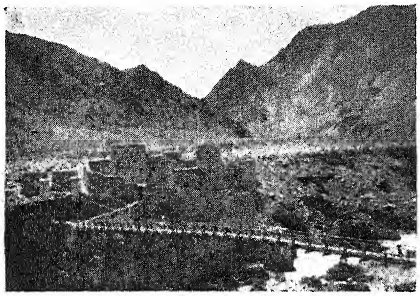


4.—Zogi La pass.

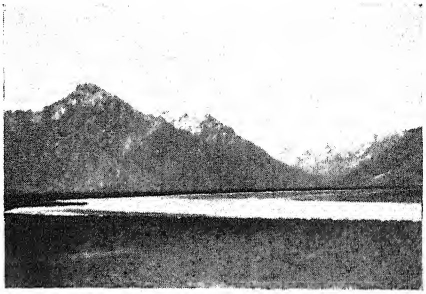
5.—Baggage pony sunk in snow beyond Zogi La.



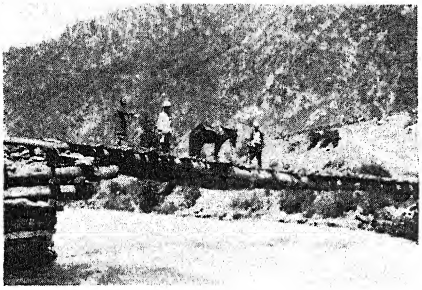
6.—Buddhist monasteries at Lamagura.



7.—Fort and bridge over Indus at Khalatze. 10,000 ft.

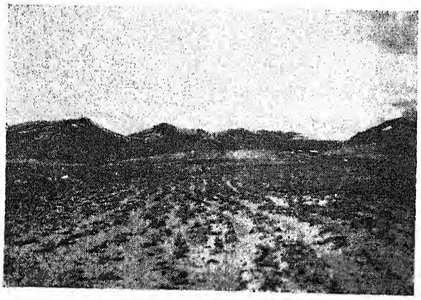


8.—Rungdum swamp at head of Suru Valley. 13,000 ft.



9.—Crossing Dras River.

10.—Junction at Shingo and Shigar Rivers.



11.—Road to Skardu over Deosai Pass. 13,000 ft.

12.—Lake at 14,000 ft., Sirsangri La between the Deosai and Kashmir.

feeding in the cultivated fields. These were *C. intermedia neglecta* and *C. rupestris*. They spend the middle of the day sitting on the cliffs above Maulbekh. We also saw a party of no less than eleven Magpies apparently engaged in a 'Panchayat'. We crossed the Namika La Pass (13,000′) about half way and then commenced the gradual descent. On the way we came across two Desert Chats and also the first Adam's Finches (*Montifringilla adamsi*) we had seen. These latter are conspicuous from the large amount of white in their plumage which they display especially on the wing. They are very tame and confiding and they show no hesitation in visiting their nests in the presence of a spectator.

June 12. We halted one day at Bodkharbu which is 11,550′ above sea level. Here we found Adam's Finch building among stones. Also two nests of the Robin Accentor (*Prunella rubeculoides*) built almost on the ground in low dense Caragana bushes (resembling gorse). We also found several Bluethroats' nests with eggs in the thorny scrub by the river. This thorny scrub (*Hippophæ rhamnoides*) is always a safe find for Bluethroats and Chiffchaffs. A snow cock was heard calling on the rocks far above our camp.

June 13. Bodkharbu to Lamaguru. Fifteen miles. Our march to-day led over the Fotu La Pass, 13,500′. We sat and ate our lunch close to a little bit of swampy ground near the Pass and watched a pair of red-billed choughs feeding close by. Afterwards, on the descent, we heard a new bird call which reminded me of the Great Rose Finch (*Carpodacus rubicilloides*) which I had previously found common and breeding near the Pangong Lake. We stalked these birds and W. shot two out of three at one shot—one a beautiful male in pink and grey plumage, the other a young male in brown striped plumage. Both were breeding birds. They proved to be Severtzoff's Rosefinch (*Carpodacus severtzovi*).

Lamaguru where we arrived in the afternoon, is at an altitude of 11,500′. It is extremely picturesque with its monastery perched on sandstone cliffs and with numerous chortens and mane walls lining the approaches to the village. The surrounding hills, especially on the south and east, are composed of a soft cream-coloured silty material fully a thousand feet in thickness—whether this was laid down under water or by air is not known.

June 14. Lamaguru to Khalatze. Ten miles. The march led first down a rather narrow ravine and later on down a valley with a big stream, to its junction with the Indus river two miles below Khalatze. The Indus here is about 10,000′ above the sea. The valley is hot and dry. We crossed the Indus by a fine suspension bridge constructed on the site of an old stone bridge built by King Naglug in A.D. 1150. The rocky gorge down which our path lay to the Indus was remarkable for the metamorphic rocks of various striking colours red and green predominating. Wild roses with deep crimson blossoms were flowering in profusion near the stream and one bush about seven feet high bore I estimated no less than 700 flowers. Another conspicuous plant was *Capparis spinosa*, with large handsome white flowers growing on the driest and hottest of sandy slopes.

We halted a day at Khalatze which, however, we did not find

very rich in bird life. Skylarks and Magpies were common, and we secured an old cock Chukor, weighing twenty ounces which belonged to the pale race *C. chukar pallescens*.

The Whistling Thrush (*Myiophoneus*) was also seen by the river and also a pair of Grey Tits (*Parus major kashmiriensis*).

June 16. Khalatze to Lamayuru. On this return march we secured a specimen of the Pied Chat (*Œnanthe picata*). We also shot a Martin (*Delichon urbica*).

In the evening we climbed up above the camp to about 12,000′ and came on a family of fully-fledged young Desert Chats, on the wing. Wild Rhubarb was coming up on the hillside at the same altitude.

June 17. We halted a day at Lamayuru, climbed up to about 14,000′ but saw very few birds. Found the nest of Adam's Finch ready for eggs in hole near base of mane wall. The birds came quite close to me as I examined a nest and did not seem to be a bit anxious.

According to plan, our next objective was the head of the Suru valley. To reach this from Lamayuru in ordinary years would be a simple matter—first two marches up the Kangi stream, and then over the Kangi Pass. This entails fording the Kangi stream about half a dozen times, which is not ordinarily difficult. This year however owing to the exceptionally heavy snowfall the Kangi stream was a formidable torrent and quite unfordable; so we had to seek out some other route.

We were told that we could get through from Lamayuru *via* Wanla and Zanskar but that the route would be longer, perhaps four marches and also more difficult. We decided to adopt this route, but we might have hesitated to do so had we known how long and difficult it was to be; for it took us ten days to do about ninety miles of very hard marching over bad tracks which were in places both difficult and dangerous.

June 18. Lamayuru to Wanla. Nine miles. First an ascent to a pass 12,000′ and then gradually down to a valley and fair sized stream with cultivation and thorny scrub at Wanla 10,500′. Here we found Bluethroats again and also House Martins and a pair of Swallows (*H. rustica*). Also a few Crag Martins with unfinished nests in a cave above the river.

June 19. Wanla to Hanupatta. Ten miles. The path follows the stream and the valley soon becomes a gorge, almost a defile and the path is reduced almost to vanishing point. We crossed the stream three times by bridges and then had to ford it twice, the first time up to our middles in water nearly ice-cold. We took off our boots and nether garments and threw them across the stream before tackling it. W.'s boots tied together, with stockings inserted, made a forced landing in midstream and were instantly whirled away in the torrent! I had visions of W. toiling up the valley bare-footed; however a plucky Ladakhi retainer who plunged into the stream without hesitation and rescued the boots a little further down in a backwater eddy where their downward journey had fortunately been arrested.

The country we were passing through was very remarkable,

Huge vertical cliffs and precipices on either side running up fully a couple of thousand feet almost shut out the sunlight. How our laden ponies got safely through this march was a marvel. There were no casualties. We arrived at Hanupatta in a more open valley and camped at 12,300′ by a solitary juniper tree nine feet in girth.

Not very many birds were seen but we secured a specimen of a Red-mantled Rose-Finch (*Propasser rhodochalmys grandis* ♂) and also Hume's Chat (*Œnanthe abboniger* ♀) as well as two Mountain-Finches.

June 20. Hanupatta to Patoksar. Ten miles. A gradual ascent, fording a stream at 14,500′ (very cold!) and then on up to the Shirshir Pass, 16,600′ where there was snow still lying. View over the hills from the pass very fine. On the ascent to-day we came across the same large Rose-Finch (*Carpodacus severtzovi*). Also *Prunella fulvescens* and *rubeculoides, Phylloscopus affinis,* pigeons of three kinds (*Columba livia neglecta, rupestris* and *leuconota*), a Raven, Choughs, Adam's Finch and Brandit's Finch (*Fringilauda brandti*). We also met with some Horned-Larks (*Otocorys longirostris*) which all appeared to be males.

Eventually we reached Patoksar and camped by a stream at 13,500′. This is the highest cultivation we have seen.

June 21. Patoksar to Ilchung. Twelve miles. A very cold, clear morning. Ice on shallow pools, and sponge frozen! Made an early start as usual and shortly got the sun which was most grateful. A little above our camp we came on three great Snow-Cock waddling along the path in front of us, like geese! Having no suitable weapon handy, they escaped. Further on heard many snow cock calling a musical loud whistle of about four notes, reminding one somewhat of the wild note of the Curlew.

On this march W. found the nest of Adam's Finch under a rock with four fresh eggs—pure white.

The path ascended gradually, culminating in the Singhe Pass 16,500′ where there was much snow including a snow cornice on the ridge. Saw many Stoliczka's Mountain-Finch and Brandt's Mountain-Finch in this march and found a Redstart's nest with hard-set eggs under a rock, and a nest of the Horned Lark (*Otocoris longirostris*) with two fresh eggs under a tuft of grass. The full clutch of this species is three or two eggs only. Our camp at Ilchung was at 13,200′. Here we found House Martins again and Choughs of both kinds.

June 22. Ilchung to Linshet. Eleven miles. First a steady climb of three miles up to the Chupa La 14,600′—Snow-Cock calling all the way—then steeply down to a valley 13,100′, followed by a second steep climb up to the Nirgūm La at 14,400′, and lastly a gradual descent to a large village and monastery at Linshet which is 13,000′.

Birds seen in the march to-day were Snow-Cock (*Tetraogallus himalayensis*), Rose-Finch (*Carpodacus severtzovi*) and the Olivaceous Tree-Warbler (*P. indicus*). The latter has a song not unlike that of the Lesser Whitethroat but not often heard.

June 23. Linshet to Oma River. Nine miles. We struck camp and packed early, as usual but for some reason no transport arrived. We waited and waited. It was evident that the people were trying

to boycott us and did not want us to go on any further. Among other objections they stated that we should meet with an unfordable river. This we found was true, but as we did not have to cross the river it was no obstacle! However by dint of much pressure and persuasion we eventually collected a mixed lot including yaks, ponies, monks and even nuns who carried our kit on to the next camp by the Oma river at 12,500′.

The march was first uphill to the Barma La, 15,500′, a very cold exposed and windy spot, then down over many snow bridges to the junction of our small stream with the big unfordable Oma river. Here we found Common Rose-Finches and Chiffchaffs again and plenty of welcome firewood (dwarf willow).

June 24. Oma river to Debring. Seven miles. The path to-day was the worst we had so far experienced. It follows the Oma river —at times along the edge of the stony bed, at others up along and over hanging precipices—involving many ups and downs of several hundreds of feet. Here, too, the path is reduced to a minimum, often only just room for one to put his foot, and it is no place for any one who has not a good head or who suffers from vertigo, as a fall would take one down several hundred feet into the riverbed with certain death. However we got through safely and what was much more wonderful was the fact that our kit loaded on eight yaks and twenty coolies also got through with no casualty. Yaks are really marvellous on bad rocky, steep slopes. On the march we secured a fine specimen of *Carpodacus severtzovi* which frequents rocky slopes.

Debring is a fair sized village at 13,100′—with a considerable amount of cultivation and a good many willow trees,—also ample water for irrigation from two streams. Here we found Choughs (both kinds), Short-toed Larks, Redstarts, House-Martins and Adam's Finch all common and on the dry slopes above, *Phylloscopus indicus.*

June 25. Debring to camp. Four miles. A short march up the valley to a camping ground below the Pass which we must cross to-morrow. Our camp was at 13,900′ among rocks with much low scrub consisting of dwarf Lonicera, Ephedra, dwarf willows, etc. W. secured an Orange-barred Willow-Warbler (*Phylloscopus pulcher*) in the willow trees near our last camp, the only one seen throughout the tour. Near our camp below the Pass we saw several of the large Rose-Finches, and our shikari found a nest built under a stone, ready for eggs.

There were many Marmots about, the Himalayan—not the Tibetan species. We also found the nest of *Phylloscopus indicus* in a dwarf Lonicera bush with four fresh eggs, and secured a second specimen of the pale race of Chukor, which is characteristic of this dry, stony, sandy country.

June 26. Camp to camp above Gompa. Nine miles. Made a very early start. The march to-day started with a climb of 2,500′. Nearly all over snow and a good deal of it deep snow, often in conical peaks or ridges making going difficult. We reached the Pass, the Pig Dong La, altitude 16,600′, at 8.30 and then started down. Our path led down a valley which gradually increased in dimensions.

At midday when we stopped for lunch it began to sleet and was very cold. We took shelter under some steep rocks and waited patiently for our kit to arrive which it eventually did and we got our camp pitched on a small plateau, everything very wet. Now, however, the sun came out brightly and every one soon revived.

Otocoris longirostris were common round our camp at 14,500′. Also a pair of Desert Chats, Redstarts, Mountain-Finches, Robin Accentors and the ubiquitous Eastern Meadow-Bunting. This latter was on the whole commonest and most widespread of all the birds we met with, the House-Sparrow only excepted.

June 27. Camp to Zuildo. Ten miles. A fine frosty morning. Saw a few Himalayan Rubythroats (*Calliope pectoralis*). We must now be near the meeting point of the two races, the Himalayan and the Tibetan (*C. p. tschebaiewi*) as the latter occurs in Southern Ladakh.

We saw and compared *Phylloscopus affinis* and *P. indicus* together. They are very similar in colour and appearance and their songs are also very similar but that of *affinis* is preceded by a single separate note which is not the case with *indicus*.

Saw a pair of *Carpodacus severtzovi.* Now we caught sight of the Gompa (monastery) and knew we were at the head of the Suru valley and approaching the great Rungdum Swamp which was our objective and which we had been keenly looking forward to as the home of the Eastern Redshank, the Lesser Mongolian Plover and the Eastern Common Tern (*Sterna hirundo tibetana*). Three miles down the open valley from the Gompa we arrived at a miserable collection of huts—the village of Zuildo, on the northern and eastern margin of the Rungdum Swamp and here we pitched our camp. It was a cold, bleak spot, very windy and with snow on the mountains on both sides of us right down to the valley. The altitude of Zuildo is 13,100′.

After ten days' very strenuous marching we arranged for a halt of five days, more especially because we were anxious to work the Rungdum Swamp thoroughly before moving down the Suru valley.

The Suru river at Zuildo is already a broad body of water and unfordable at this time of the year. The stream is not very rapid probably averaging about three miles per hour for the eight miles as it skirts the Rungdum Swamp.

The swamp occupies the whole valley which in this portion has widened out and is nearly a mile across. It is caused by a series of large springs which arise at the base of the mountain range which constitutes the northern flank of the valley. A fair proportion of the swamp consists of marshy grass land with tussocks of coarse grass, reeds and sedges, and innumerable little pools and channels of water, some fairly deep. Progress here is not easy but with care and circumspection combined with considerable activity it is possible to explore a good deal of it on foot. Another type, well represented, is covered with dwarf willow of which three or four species are common. Mosquitoes (*Culex sp.*) are very numerous, but owing to the unusual cold they were not nearly as bad as had been experienced by the writer on a previous visit.

Our camp at Zuildo was close to the river with the swamp on

one side of us and a large area of stony, sandy waste, a 'fan' resulting from a side stream, occupying the other.

We were surprised to see a party of eight Bar-headed Geese (*Anser indicus*) swimming about on the river close to our camp and throughout our stay they appeared from time to time and disported themselves sometimes in the water and sometimes in the land. They did not appear to be breeding, though at this time of the year they would have eggs or freshly-hatched young in Southern Ladakh near the Tsomoriri Lake or at Shushal. We also saw a few Goosanders on the river on one or two occasions and a flight of eight Pintail Ducks were also seen.

The Eastern Redshanks were fairly common in the swampy area. They were naturally shy but we soon found that they had in most cases either hard set eggs or freshly hatched young. As a result of much searching in the swamp and watching with glasses we found one nest with fresh eggs and several chicks. The eggs were laid in a tussock of grass in the swamp.

Several pairs of the Lesser Sand Plover (*Ægialitis mongolica*) occupied the stony 'fan' west of our camp and others on similar ground nearer Gompa. The birds are extremely difficult to follow as they run about at great speed on the sand and their eggs, three in number, are extraordinarily difficult to locate. One may pass them over and over again at close quarters without seeing them. We succeeded in finding three nests with eggs and several chicks, but one nest of eggs, an incomplete clutch, was washed away by a rise in the river and another lot were very hard set. One lot of three fresh eggs was however secured—which were pale *cafe-au-lait* rather densely speckled and spotted with dark brown. The eggs are laid in little saucer-shaped hollows in the sand scraped out by the bird generally at some considerable distance from the water.

A few of the terns we were in search of were seen from time to time generally fishing over the larger pools near the swamp. They were usually either single birds or in pairs. We could see no signs of breeding. Three specimens were secured. The bird turns out to be *Sterna hirundo tibetana.* Other birds seen in and around the Rungdum Swamp were :—

Skylarks (*Alauda arvensis guttata*), very common and breeding. We found several nests in the drier portions of the swamp. Horned Larks (*Otocoris alpestris longirostris*) and Yellow-headed Wagtails (*Motacilla citreola calcaratus*) extremely common everywhere in the swamp. Many nests found with eggs usually very well concealed in grass or at base of dwarf willow.

The Robin Accentor (*Prunella rubeculoides*) was also very common and breeding on ground at base of dwarf willow or merely in hole in tussock. Eggs three; colour as in hedge-sparrows.

Tickell's Willow Warbler (*Phylloscpous affinis*). Fairly common and breeding in the low willow scrub in the swamp. Fresh eggs taken. The Chiffchaff (*Phylloscopus collybita sindianus*). Fairly abundant, breeding in the dwarf willows in the swamp. The Himalayan Rubythroat was also occasionally seen near the edge of the swamp or on the hillsides above it. The Cuckoo (*Cuculus canorus*) was also heard calling nearly every day. Choughs—the

red-billed variety—were often seen near our camp. Pigeons, chiefly the Blue Hill-Pigeon (*C. rupestris*) and also the Snow Pigeon (*Columba leuconota*) were commonly seen. Lastly, House-Martins (*Delichon urbica urbica*) and Crag-Martins were observed on several occasions and were breeding on the cliffs.

July 3. Zuildo to Gulma Tongas. Eleven miles. Our march to-day was alongside the Rungdum Swamp for about six or seven miles and then through thickets of willow and open country. Our camp was near the site of the Gulma Tongas village, now deserted. It is a delightful open spot, elevation 12,200′ with a tarn of about an acre in extent close to the camping ground. There were ten Bar-headed Geese on the river close by, and a few Green Sandpipers, very wild, on the margin of the tarn. Those were doubtless non-breeding birds. We found a Horned Lark's nest with two slightly-set eggs close to our tents. This was discovered in a curious way. All through the bustle of men and animals involved in the pitching of our tents the lark had sat tight and refused to leave her nest. Later on I had opened up my Botanical press and spread the paper out in front of my tent to dry. Even this did not disturb the bird. Suddenly a gust of wind took away several sheets of paper one of which blew away close over the nest. This was too much for the bird which flew off, disclosing the nest. The nest was in a depression in the ground surrounded by a rampart of stones, some of which weighed from half to one ounce each !

We also found the nest of a Lesser Sand-Plover on a stony, sandy flat containing two freshly-hatched chicks and one egg. The nest was discovered owing to the extraordinary antics of the mother bird which shuffled about on the ground looking more like an animated bunch of feathers than a bird. We sat down within a few feet of the nest and the parent bird came slowly up to within about six feet of us. She did this for some time and finally got tired of the performance and stood up. While engaged in her strange antics we took a photo—but unfortunately, it does not show the bird! The next morning she was covering the chicks a short way off and we removed the single egg which proved to be addled.

July 4. Gluma Tongas to Parkachik. Ten miles. Our march to-day was through a lot of interesting rocky country still following the Suru river. The river had become much more rapid in places, in fact a roaring torrent or cascade and the valleys was in places full of enormous boulders weighing many hundreds of tons which had come down from the steep and lofty mountains on either side.

The flowers were extraordinarily beautiful including the lovely little purple *Primula minutissima,* the large purple blue *Primula nivalis,* in masses by the streams, the yellow onion, *Allium semenovii* and the small *Allium stracheyi* in the swamp, two buttercups (*Ranunculus pulchellus* and *chœrophylla*), the dwarf *Thalictrum alpinum,* the golden *Potentilla argyrophylla,* the pink *Dianthus angulatus,* the beautiful little *Androsace zabulensis, Anemone albana, Saxifraga sibirica,* the purple *Lancea tibetica.*

Also *Draba glacialis* in golden masses, the deep the blue Gentian, *Gentiana carinata* in swampy places, and on dry warm slopes *Arābis*

tibetica, the deep blue *Martensia echioides* and the pink Thyme (*Thymus serpiphyllum*).

Three species of Louse-wort, crimson, pink and yellow (*Pedicularis pyramidata, siphonantha* and *cornuta*) were common on damp ground. Also the Edelweis (*Leontopodinm leontopodium*) and the lovely silvery *Anaphyllis xylorhiza* and *maritima. Campanula aristata* was also seen, though not common, and also *Chrysanthemum tibeticum* and *Aster tibeticus.* The curious gnetaceous, dwarf, shrub-like plant *Ephedra Gerardiana* with its golden flowers was also exceedingly common on dry rocky slopes and several species of sedge and rush were dispersed throughout the swamp. There was no tree growth at all, with the exception of dwarf-willows usually only three or four feet high or less, exceptionally about eight feet high.

As we approached Parkachik we came under the lower slopes of the giant Nun Kun whose three-fold summit exceeds 23,000′. This mountain was explored by Dr. E. Neve and subsequently two of its three peaks were climbed by Dr. and Mrs. Bullock Workman and Count Calciati. The highest peak of the three, the Dome, has not yet been attempted.

The Nun Kun mountain is an extraordinary fine mass and the view of it from Parkachik is most imposing. Several large glaciers descend from its slopes. One of these ends abruptly in the Suru river close to Parkachik where its tail is washed by the waters of the river. The great Barmal glacier which also takes its rise on this mountain after a course of no less than fifteen miles flows into the Wardwan Valley below the Bhotkhol Pass. A month or two in June, July and August might be profitably spent exploring the slopes, the peaks and glaciers of this mighty mountain mass, and I commend this adventure to any enterprising naturalist with a penchant for exploration.

On the march to Parkachik young Horned-Larks, well on the wing, were seen, also several Rubythroats, and a nest of this species in a hole on a grassy slope among shrubby growth, containing three half-fledged young. *Phylloscopus indicus* and *affinis* were again common and a nest of the latter with fresh eggs was found. Also a Chiffchaff's nest with four eggs. A single Lämmergeyer was seen.

July 5. A halt at Parkachik, a picturesque village perçed up on the hillside at 11,000′, five hundred feet above the river. The morning was spent down in the thorny scrub (*Hippophæ rhamnoides*) of which there are large areas occupying many acres of the wide stony bed of the Suru river. The Ibis-bill (*Ibidorhynchus struthersi*) was seen on an island, where it had doubtless bred. Common Sandpipers were also seen here. This altitude (11,000′) appears to be about the upper limit of the breeding of both these species. In the thorny scrub Bluethroats, Rubythroats and the Large-billed Bush-Warbler (*Tribura major*) were common. Chiffchaffs, Common Rose-Finches (*Carpodacus roseatus*) and the Gold-fronted Finch (*Metoponia pusilla*) were also numerous.

A nest of *Tribura* deep in a thorn and artfully concealed in grass was discovered. It contained four fresh eggs. These, and the nest,

resemble those of the European Grasshopper-Warbler, and indeed these species are evidently very nearly allied. The bird of this nest, when disturbed, ran away through the grass exactly like a mouse and never took flight. She was betrayed by the movement of the grass as she ran and had I not been specially on the look out for this bird with whose habits I was acquainted I should never have been aware of the nest.

A brood of young Rubythroats strong on the wing, was also seen, and a nest of the White-capped Redstart (*Chaimarrhornis leucocephalus*) was discovered, with four fresh eggs in a hole in a rocky cliff.

July 6. Parkachik to Suru Bridge. Five miles. The Suru river takes a great U shaped bend at this point fully twelve miles in circuit whereas by crossing over a pass at the narrow neck of the U above Parkachik the distance is reduced to about two or three miles only. The climb up to the pass is steep and rocky. The view from this point which is about 12,000′ is very grand, as it commands the whole of the Nunkun massiff on the one side and the Himalaya trending in the direction of the Zoji La in the other.

On this march we were anxious to search for a little owl which our shikari Lala had reported the previous day, and so far we had found no owl inhabiting this dry, rocky, sandy country above the tree limit. Lala led us up to a very steep rocky ridge and sure enough there was a little owl looking at us from a ledge some way up. Before we could secure him he retreated into a crack in the rock and obstinately refused to show himself again. We scanned the rocks above and below and shortly W. spotted another similar owl a good deal higher up. I stalked this bird with the ·410 keeping very carefully out of sight and directed by W. from below. It was exciting work as we did not know what this owl would be and were most anxious therefore to secure a specimen. At last a point was reached from which I judged I should see the bird within easy shot, and exposed my head, but no, it had moved on. Another short stalk and a shot was obtained and the bird disappeared over the edge of the rock on which it was sitting. When I fired it had a small bird in its claws. I hurried forward and looked over the precipice but saw no signs of the owl. I then climbed down to where, if hit, it should be lying, but at first could find nothing but the body of a Stewart's Bunting which it had held in its claws. Shortly, to my joy I spied the owl on the ground. It proved to be a fine specimen of a race of the Little Owl (*Athene noctua bactriana*), previously unrecorded from Ladakh, Baltistan or Kashmir. It appears to be a rare bird in Ladakh, and we only saw one other pair, also not far from Suru Bridge. On the way down beyond the pass a specimen of Brandt's Mountain-Finch (*Fringillauda brandti hœmatopygia*) was secured. These rather large finches of dull brownish colouration, except for a pinkish patch on the rump, are fairly common from 12,000′ upwards, especially in moist places. They occur in pairs and small parties and doubtless breed under rocks and stones though I have never succeeded in finding a nest, in spite of much time and trouble spent in search.

Two days were spent at Suru Bridge, our camp being pitched near

the wooden bridge—a rather perilous affair—but the only available crossing for many miles up and down river. We found nothing new at Suru Bridge but found nests with eggs of Bluethroats, Large-billed Bush-Warblers, Robin Accentor, Yellow-headed Wagtail, Chiffchaffs, Tickell's Willow-Warbler, the Skylark, the Eastern Meadow-Bunting, the Horned-Lark, the Short-toed Lark and Gold-fronted Finch.

The last had just commenced to breed—a beautiful little nest lined with white willow cotton resembling that of a Lesser Redpole or Gold Finch, only not quite so neat, placed in a low briar with usually five eggs similar in colouration to those of the Linnet, only of course smaller.

July 9. Suru Bridge to Sanku. Thirteen miles. All our kit had to be carried over the bridge by our pony men as we did not wish to risk losing it. One pony belonging to another caravan fell over the bridge but without a load and was rescued down below.

Skylarks, Bluethroats, Gold-fronted Finches and Common Rose-Finches were common on the march. Pied Wagtails (*M. alba alboides*) were also seen and a hobby. A Lämmergeyer was also seen and a pair of Kestrels with a nest high up on a cliff. Carrion-Crows and Magpies are now common again, and willow trees and poplars are found everywhere. An Ibis-bill was seen by the river.

Sankhu is a large village occupying a fine, broad area of good cultivation opposite the tri-junction of the Kartse, and Umba streams with the Suru river.

Here we found Large-billed Bush-Warblers, Bluethroats, Gold-fronted Finches, the Rose-Finch, Skylarks and Yellow-headed Wagtails all extremely common. The Rose-Finches are now first beginning to lay. The nest resembles that of a linnet and is built usually in a low thorny bush (*Hippophœ*). The eggs, four, very rarely five, in number are dark blue marked with brownish or black specks. Many swifts (*Cypselus apus pekinensis*) were seen hawking flies, and two cuckoos, were still calling.

July 11. Sankhu to Tsalikot. Ten miles. Our road still follows the river and our camp was at 9,400′. Rose-Finches were common and several nests with eggs were found.

Gold-Finches also seen but no nests found. A lesser Whitethroat's nest (*Sylvia althca*) was seen with three young and a pair of *Phylloscopus indicus* feeding young. A fully-fledged young *Œnanthe pleschanka* was secured.

July 12. Tsaliskot to Maingni. Eight miles. Ne new birds seen except three Ravens and a pair of Grey Wagtails. The common grey Quail was calling 'Wet-my lips' round our camp but we could not discover its eggs.

July 13. Maingni to Kargil. Seven miles. We are now back in 'civilization' again—the first 'shops' we have seen for six weeks, and a big budget of letters. It was warm with bad sandflies at night. Ripe apricots were arriving from Skardu, a welcome change as we had seen no fresh fruit since we left Srinagar three months ago!

Two days were spent at Kargil repacking our kit and sorting out spare stores, etc., to be sent back direct to Srinagar.

Our next objective was the Deosai Plains to be reached *via* the Shingo-Shigar River, a difficult route.

Bluethroats' nests with eggs and with young, a *Tribura* nest with eggs, two lesser Whitethroats' nests and a Chiffchaff's nest were all we found at Kargil. Apricots were not yet ripe here.

July 16. Kargil to Karkitchu. Seven miles. Our road took us down the Suru river for about two miles then across the Skardu suspension bridge, over the Dras river and up its left bank as far as the village of Karkitchu where we camped in the welcome shade of apricot trees. A Bluethroat's nest, found the previous day with three fledged young, was taken and the young fed on insects, grass-hoppers, earwigs and beetles, etc., on the march.

A young Blue Rock-Thrush (*Monticola cyanus*) was obtained.

July 17. Karkitchu to Chani-Kai. Ten miles. Visited the nest of a new species of Rose-Finch found the evening before in a low briar. The nest contained one young bird and three addled eggs; pale blue sparingly spotted black. The bird was identified satisfactorily as *Propasser rhodochlamys grandis.* The path was very rocky and difficult. While resting for lunch under an apricot tree a mouse-hare about as big as a guinea pig came out and munched green leaves quite close by.

Our march followed the Shingo-Shigar river which has a large volume of water beautifully clear and is a great contrast to the Indus, Dras, Suru and Oma rivers all of which were more or less muddy or turbid with glacier water.

July 18. Chani-Khai to Matiyal. Twelve miles. We made an extra early start as the heat of the previous day had been very trying in spite of the elevation (nearly 11,000′). Soon after the start we came on a number of House Martins hawking flies over the fields. We shot one for identification. It was *Delichon urbica urbica.* The path was the worst we had ever experienced. There was in fact practically no path, and we had to climb over broken stone and boulders, often of large size, which was very tiring work as one had to place one's feet carefully. How our loaded coolies managed it was really a marvel. This was the hottest march of the whole tour, and we had a perpetual thirst which, however, we could slake in the almost ice-cold streamlets which we crossed at frequent intervals.

We halted at midday in a delightful shady place by the river, a thicket of willows, juniper and *Myricaria elegans,* the latter a characteristic large shrub of many of the valleys of Ladakh with very lovely spikes of small pinkish white flowers. Wild roses with deep crimson flowers were also in evidence.

We were told it was two miles on to Matiyal; so we decided to push on though we were rather done. It proved to be fully five miles with a steep climb of 800 feet at the finish!

We passed the junction of the Shingo with the Shigar river on this march. The former drains the Chota Deosai Valley. We follow the latter, which is now of a beautiful clear dark green, and in places a roaring torrent. Matiyal village consists of only a few huts. It is situated on a large cultivated plateau well above the river with a scattered forest of juniper and *Pinus excelsa* not far off. The presence of forest trees indicates a moister climate.

We halted a day at Matiyal to arrange ponies to replace our coolie transport. We explored the forest area and saw, among others, the Simla Black-Tit (*Lophophanes melanolophus*) only seen in this valley since crossing the Zoji La. Also *Phylloscopus humii* and *indicus, Propasser rhodochlamys grandis, Carpodacus roseatus, Metoponia, Emberiza cia stracheyi, Phyrrocorax phyrrocorax* and *Columba leuconota*. Also, near our camp, skylarks and short-toed larks.

Two species of juniper were common, one an erect tree and the other a squat spreading shrub. A species of Rubus was also observed. Biting flies were very troublesome, a species of *Tabanus* as well as a *Simulium*.

July 20. Matiyal to Karbos. Nine miles. A river had to be forded by our ponies shortly after leaving Matiyal, after which the path was much up and down and often over very bad rocky ground over which one would not think of leading an ordinary pony without a load, but the wonderful little local ponies carried our loads right through without a casualty.

On the march we saw Bluethroats (white spot), a large Rose-Finch (*? Propasser grandis*), Gold-Finches and Black-Tits (*Lophophanes rufonuchalis* again. Many beautiful flowers including pure white King-cups yellow Louse-wort—some two feet high, and masses of purple Cranes-bill. Butterflies were also fairly numerous, Blues and Coppers and a Fritillary new to us.

Biting flies and mosquitoes were again very bad.

July 21. Kartos to camp by river. Eight miles. A muggy damp morning. Mosquitoes very bad. The path was better than the previous day but still bad in parts.

On the march we saw traces of Red Bear and came across *Acanthopneuste viridanus* for the first time and secured a specimen. They frequent the willow patches on the hillside. We also heard *Phylloscopus, indicus, humii* and *collybitus*. Other birds seen were Swifts, Redstarts, Sky-larks, White-capped Redstarts, Common Rose-Finch, Tree-Pipits, Blue-headed Robins and Rubythroat. May flies were very numerous at our camp.

July 22. Camp to camp Domel. Ten miles. We are now nearing the 'Promised Land'—the Deosai Plain, which we have been eagerly looking forward to! The whole of this march was through millions of May-fly (*Ephemera*) sometimes in dense clouds in the air, and also seated upon the vegetation, chiefly on Dock leaves. There were many swifts about feeding no doubt on the May-flies. The May-flies were a godsend to my young Bluethroats who consumed them in large quantities.

Our path gradually became easier as we approached the Deosai. Finally we were confronted with a broad swiftly flowing river which had to be forded before we could reach our camp. It looked a tough proposition, the more so since the water was nearly ice-cold. However we decided to tackle it, and W. and I stripped of all clothing, set out armed with a stout stick each. We managed with much difficulty to get nearly to midstream but the current was very strong, and we were constantly losing our feet and in this cold water there was some danger of being completely

carried away. We struggled back with difficulty and held a council of war. We decided to try again with the help of the ponies. I mounted one and W. seized its tail. A pony man held on to the bridle. In this way we managed to get safely across but it was touch and go.

Our kit was rearranged on the ponies with such articles as it was essential should not get wet loaded on the top, and the ponies and men then came across in a mass the men hanging on to the ponies. All got safely over. We were feeling very cold and lay down in the sun on the hot stones with our clothes spread out to dry. This soon gave us fresh life, and we pushed on two miles to our camp on the Deosai.

Birds on to-day's march were a strange, large eagle, two Pallas's Fishing-Eagles, Rubythroats, Redstarts, Horned-Larks, Skylarks, Tree-Pipits, Common Rose-Finch, Mountain-Finch, Swifts, Yellow-headed Wagtails and Chiffchaffs. Also a cuckoo being mobbed by a Rubythroat.

July 23. Halt—Domel.

We had been eagerly looking forward to the Deosai plains, this strange extensive uninhabited plateau of moorland and swamp some 300 square miles in area, drained by numerous big streams, full of fish, surrounded by lofty snow clad mountains and subject to icy blizzards in almost every month of the year.

The wild beauty of the moorland with its lush green grass and carpets of alpine flowers alternating with drier stony or sandy areas and its clear, cold streams with dwarf-willow beds is undeniable, but it was absolutely spoilt at the time of our visit by the almost indescribable plague of mosquitoes. These bloodthirsty pests were present in millions and the swiftness and pertinacity of their attacks was quite extraordinary. I had had many years' experience of mosquitoes in the tropics, including Burma, but they were as nothing compared to these voracious tigers of the Deosai Plains. Their attacks commenced about half an hour after sunrise and went on to about an hour after sunset. They were at their worst in the morning and evening hours. The species was a *Culex* of rather large dimensions. Fortunately we had been warned and had provided ourselves with head nets, but working in head nets is a nuisance at best. We had not been an hour on the Deosai when we were as anxious to leave it as we had been to reach it.

Red Bears are said to be numerous on the Deosai and to catch fish from the streams with their claws. We did not actually see any but we saw their traces. Marmots were very numerous in places. Birds were not very numerous either in individuals or in species. The chief birds seen were Horned Larks (*O. longirostris*), Pipits (*A. roseatus* and *trivialis*), Rubythroats, Robin Accentors and Yellow-headed Wagtails. Also a few cuckoos. On the dry, stony plain a few of the Lesser Sand-Plover were seen. We collected several Horned-Larks which appear to be identical with the *Otocoris alpestris longirostris* found at Dras and elsewhere on our tour.

July 24. Domel to Chandarkot. Nine miles. Our march lay over the moor. Mosquitoes were terribly bad till about midday when a cold wind got up and banished them. We saw a grey Heron,

a Peregrine and a Golden Eagle to-day. The latter probably feeds on marmots in this part of the country.

Our camp was in a delightful spot near the meeting of two streams with swampy ground rich in flowers, near by. Here I found among other things the beautiful little *Primula rosea* previously unrecorded from Baltistan.

July 25. Chandarkot to Chota Deosai. Eleven miles. Our path followed the Kalapani stream up to its source near the San Sangri La (Pass) altitude 14,200′. At the pass there are two beautiful tarns, half a mile or so across. There was much snow at the pass and on the neighbouring mountains. From the pass we had a steep descent to the valley of the Chota Deosai where we camped by a large stream, the head waters of the Shingo river. We saw a pair of ravens standing by the body of a dead pony by the way. No new birds were seen. Fortunately a cold wind was blowing near our camp so that we were not much troubled by mosquitoes. A most unfortunate incident was the loss of W's field glasses, which he left lying not far off where we rested for lunch and which were almost certainly stolen by a Gujar who passed by, the only man who had passed us for days.

July 26. Chota Deosai to Minimarg. Fifteen miles. The night at Chota Deosai was marked by a hard frost. Our tents were white with rime and our sponges and water in basins frozen. A gradual ascent of one and a half miles brought us to the Panzil La at 13,000′, from which point a gradual descent to Minimarg at 9,333′ near the head waters of the Kishanganga river. We passed the Burzil Resthouse on the Gilgit road a few miles before reaching Minimarg. Here we obtained specimens of *Acanthopneuste viridanus* and the Tree-Pipit (*Anthus trivialis harringtoni*).

Since we crossed the Panzil Pass there has been a marked change in the climate and vegetation, hillsides being clothed with forest of birch and lower down with silver fir and blue pine and shrubs of various kinds. Minimarg is a small village with a post office.

We were disappointed to find that mosquitoes were fairly bad at Minimarg. We had hoped to have left them behind at the pass!

We halted a day at Minimarg.

July 27. Explored the Nagai valley. We found Hodgson's Shortwing (*Hodgsonius phœnicuroides*) common in the open parts of the fir forest and secured specimens of both old and young birds. Also a young Buzzard (*Buteo buteo*).

July 28. Minimarg to Dudgai. Fourteen miles. Our march led down the Gilgit road on the sunny side of the valley, the opposite side being clothed with forest of silver fir and blue pine.

We heard *Hodgonius* calling, a rather melancholy refrain of three notes, the middle one lowest. Also *Acanthopneuste magnirostris,* its call, tee—tee-tee—tee-tee, a descending cadence of loud and shrill notes could be heard above the noisy turmoil of the torrent.

We were delighted to find no mosquitoes at our camp at Dudgai, 8,350′ altitude.

July 29. Dudgai to Barman. Ten miles. A pretty march down the Burzil river. At Gurais the valley opens out and there is much cultivation and several large villages. We camped near a big poplar

wood, with excellent shade and water. The poplars were up to twelve feet in girth and eighty feet in height. We were surprised to hear Chiffchaffs calling in the willow beds near the river. We did not know they bred in Kashmir proper. We also saw a Magpie. Rufous-backed Shrikes and Grey Tits were common.

July 30. Barwan to Gorai. Eleven miles. Our road led us at first down stream through a fine wood of silver fir, blue pine, walnut, hazel and elm. Heard many *Acanthopneuste magnirostris* and secured specimens with some difficulty. The last part of our march was steadily up a side valley to our camp at Gorai, 9,000′. There is still snow lying in considerable quantities in nalas, which is very unusual here in July.

We had a very heavy thunderstorm in the evening.

July 31. Gorai to Tragbal. Twelve miles. A glorious morning, *Myiophoneus, A. magnirostris* and *Hodgsonius* all very noisy. The road climbs steadily up to the Raj Diangan Pass altitude 11,580′ from which point we obtained magnificent views over the valley of Kashmir, the Wular Lake, the Pir Panjal Range, Hara Mukh Mountain, etc. The open grassy slopes were a mass of golden *Potentillas* and *Geum* with dark blue *Martensia,* and many other flowers. Before reaching camp we came across a number of *Ægithaliscus niveigularis* in a hunting party and secured specimens. Red-browed-Finches (*Callacanthis burtoni*) were also common and we shot a young bird of the year.

Our camp at Tragbal 9,500′ was in the shade of deodar trees, a delightful spot. We experienced a sharp thunderstorm in the evening, fortunately after our tents were pitched.

We halted three days at Tragbal.

August 1, 2, 3. The country around Tragbal is mostly densely wooded, with deodar, silver fir and blue pine on the prevailing species. Also wild cherry, maple and elm, with birch at higher levels.

Birds were very numerous. Among those seen were Nutcrackers (*N. multipunctata*), Jungle-Crows (*C. coronoides intermedius*), Tits (*Lophophanes melanolophus* and *rufonuchalis, Ægithaliscus niveigularis*), Tree-creepers (*C. himalayana*), Nuthatches (*S. leucopsis* and *kashmiriensis*), Warblers (*Phylloscopus proregulus* and *humii*), Blue Chats (*Larvivora brunnea*), Bush-Robins (*Ianthia rufilata*), Scarlet Minivets (*P. brevirostris*), Pied Woodpeckers (*Dryobates himalayanus*), Willow-Warblers (*Acanthopneuste occipitalis*), Fly-catchers (*Hemichelidon sibrica, Cyornis superciliaris* and *bicolor,* and *Alseonax ruficauda*), Red-browed Finches, Eastern Meadow-Bunting and Turtle doves (*Streptopelia orientalis*).

We secured a young *Larvivora brunuea* with short tail which had evidently only just left the nest. The body plumage was squamated as in young robins but the wings and tail were decidedly bluish as in the adult male, which is interesting.

August 4. Tragbal to Bandipore. Twelve miles. A steep descent from 9,500′ to 5,000′ through dense forest. It was rather hot when we got down and we were glad of the shelter of our house-boat which we found moored to the bank of the Wular Lake. We waited for our kit to be loaded on board and then started across the lake.

It was very different to our last crossing in April. The water of the lake was much lower and various water plants, chiefly the yellow flowering *Limnanthemum nymphœides* (which is excellent pony and cattle fodder) and the water nut (*Trapa bispinosa*) almost covered the surface in places. We arrived safely on the far side of the lake in time for a cup of tea and then entered the Jhelum river,

August 5. This was spent being paddled, poled or towed up the Jhelum river. We stopped at Sumbal *en route* and spent an hour or two on a jhil in a dug out. Here we saw numbers of great Reed-Warblers (*Acrocephalus stentoreus*), Whiskered Terns, Little Bitterns and Dabchicks and found nests, with eggs of the Reed-Warbler, and nests with eggs and young of the Tern. A nest of the Little Bittern contained six young of various ages from about three to nine days. They were the most comic little scare-crows with their tufts of long cream coloured hairs.

August 6. We arrived back in Srinagar after 109 days on trek. It was a great relief to relapse into the luxuries of hotel life for a few days. We were however quite busy for the next five days re-sorting and packing our collections and kit, selling off our spare stuff and making ourselves respectable before returning to Europe.

Of the three young Bluethroats I got at Kargil, one escaped on the Deosai, and another was killed by the large black ants so common in Rawalpindi. The sole survivor got safely to England after numerous vicissitudes and after a successful moult carried out in September on board ship settled down in excellent health in Oxford and lived through the extra severe winter on a diet of raw meat, pea meal and hard boiled egg helped out with meal worms. Unfortunately it escaped on March 10 and has never been heard of since.

Possibly it will be produced in a stuffed condition as the latest addition to the list of British Birds !

The photographs illustrating the tour are by Mr. Whistler.

THE FLOWERING OF BAMBOOS

BY

E. BLATTER, S. J., PH.D., F.L.S.

PART II

(*Continued from page 921 of Vol. XXXIII*)

When Munro, in 1868, published his 'Monograph of the Bambuseæ, including descriptions of all the Species', he enumerated 220 species. Gamble in his 'Bambuseæ of British India' (1896) described 119 species from India, Burma, the Malay Peninsula and Ceylon. Since then 24 new species have been added and a few of the old ones reduced (See the writer's paper 'The Indian Bamboos brought up-to-date' in the *Ind. Forester*, Oct. and Nov. 1929.)

At present the total number of species of Bamboos from all parts of the world amounts to about 500. I say on purpose 'about', because not a few species are doubtful or very imperfectly known. As far as India and Burma are concerned, future explorations, especially in Burma, will add at least thirty-five species, including all those which are so imperfectly known at present that we are not even able to assign them to the right genus.

As mentioned in the introduction, the list given above contains all those species of bamboos of the Old and New World of which any records as to the flowering time came under my notice. But the majority are Indian. The total number of species in the list is 137 and of varieties 11. Of 58 species and 2 varieties we possess only one record and we cannot, therefore, make use of them for our purpose.

The difficulty of obtaining flowers of bamboos has always been very great. Humboldt mentions that Mons. Mutis botanized for 20 years in a country where *Bambusa Guada* H. & B. (now *Guadua angustifolia* Kunth) formed marshy forests stretching for miles, without finding one specimen in flower. Humboldt found it worth while mentioning that Bonpland found it in flower once. Roxburgh, whose power of observation cannot be denied, confesses that he had only once the opportunity of seeing *Bambusa Balcooa* in flower. This was at the beginning of the nineteenth century and since then very few specimens have been gathered. A perusal of Gamble's Monograph leads one almost to the conclusion that bamboos were avoided on purpose. I suppose practical difficulties in gathering and preserving such stubborn and unmanageable specimens has to do a good deal with the scarcity of bamboos in herbaria.

In order to make a number of statements in the following pages intelligible, we must first explain some structures which are peculiar to the bamboos and which greatly influence the phenomena of flowering characteristic of the various groups and species.

TWO KINDS OF RHIZOME

The woody stems or culms of bamboos always arise from woody root stocks or rhizomes. There are two more or less distinct types of rootstock. One kind consists of short twisted and entangled masses producing clumps or tufts of more or less densely packed stems. In this case the bamboo is described as cæspitose. Here the rootstock is short, and more or less directed downwards; the nodes are close to each other and provided with a cluster of small rootlets. In addition we mostly find at every node a bud which will develop either into a root-branch or into a stem. The branches of the rhizome get entangled and increase in number with the age of the rhizome, and, if they are very close together, it may happen that the whole clump of bamboos is raised more than a yard above ground. These root-branches develop during the same year which produced that part of the rhizome from which the branches sprang.

The rhizomes and their branches give rise to stems during the following 3 or 4 years. The stems first grow horizontally for a very short distance, then turn at a right angle and grow upwards close to the existing culms. Two very common Indian bamboos, viz. *Bambusa arundinacea* Willd. and *Dendrocalamus strictus* Nees, can serve as examples of this type of root-stock.

In the other kind of rhizome long underground branches are produced from which single stems or tufts of stems arise. The depth at which the root-branches creep underground is very variable; it may reach two and even three feet or the branches may creep on the ground. Usually these branches follow fairly regularly a straight line which is only diverted by some obstacle. Very often the branches go round the obstacle and again assume the original direction. The rootstock and its branches often show considerable vegetative action during the greater part of the year which is only reduced in winter. It is especially after the plant is several years old that the life-intensity becomes more pronounced. As in the preceding group the nodes of the rootstock are provided with clusters of rootlets and with buds arranged alternately to the right and left and at a distance from each other which remains fairly constant for specimens of the same species. The young shoots are lateral, arranged on an almost straight line. In opposition to the cæspitose or tufted bamboo, the stems growing from the second type of rootstock are called isolated or spaced. It must, however, be noted that there is no strict rule for this classification and that the climate may, within certain limits, cause modifications.

From the rhizome-branches of *Melocanna* v. g. there arise at intervals single stems. Stapf reproduces a note supplied by C. B. Clarke on a species of *Melocanna*. 'When I was at Dacca in 1868, an officer who had been on survey in the East Cachar Hills, showed me a large seed of *Melocanna* . . . . . He told me that this bamboo occupied 6,000 square miles of country; that it had fruited the last season; that he stopped his survey six weeks earlier owing to the fall of seeds breaking theodolites and plane tables; that the whole of the old plants had died after seeding; that the whole country could be seen covered with seedlings; in 1885 I marched from Muneypoor to Cachar, across the country reported to me by the surveyor in 1868, and was for several days in a uniform, almost pure jungle of *Melocanna*.—The powerful stolons formed a horizontal mass, and I with difficulty dug up the end of one, . . The stems of this bamboo, erect, solitary, about 1–2 yards apart, occupied the ground almost exclusively, with no jungle under them, and shut out all view.'

Other bamboos again, with the same type of rhizome, produce from the horizontal root-branches tufts of stems instead of only one culm; this can be observed in several species of *Phyllostachys*. Intermediate forms between the single-stemmed and tufted bamboos are not wanting. Here belongs *Dendrocalamus membranaceus* Munro which produces loose or open clumps.

Various Types of Flowering

The habit of flowering in bamboos is very varied. Brandis, the pioneer in the exploration of this important group of Grasses, distinguishes three classes :—

1. Those which flower annually or nearly so.
2. Those which flower gregariously and periodically.
3. Those which flower irregularly.

This division is fairly complete, especially as all those species which cannot be grouped under 1 or 2 will necessarily go to class 3, though it might, theoretically, be advisable to make some subdivisions as there are a few species which occupy an intermediate place.

Annual Flowering

In annually flowering species the same plant produces leaf-bearing and flowering culms. The flowering stems have a panicle of flowers at the top and bear no leaves or leaves in the lower part, and the plant does not die after seeding.

To this class belong the Indian *Arundinaria Wightana* Nees (Brandis has by mistake *Wightii* in Ind. Trees 662) and *A. elegans* Kurz[1]. It is strange

[1] Munro in his Monograph puts *Arundinaria falcata* Nees, *A. khasiana* Munro, *A. hookeriana* Munro and *A. intermedia* Munro under section II

that *A. falcata* Nees flowers periodically at long intervals, whilst its variety *glomerata* flowered almost every year at Kew on a certain number of culms, but the plant as a whole did not suffer, and must, therefore, be classed with the annually flowering species. In Brazil the annually flowering bamboos are better represented than in India and they belong chiefly to the genera *Arundinaria*, *Guadua*, *Bambusa* and others. Of Indian species we may still mention *Bambusa lineata* Munro which, according to Gamble, is constantly found in flower in the Botanic Gardens of Calcutta and Peradeniya, but otherwise indigenous in the Andamans and the Indian Archipelago. *Ochlandra stridula* Thw. of Ceylon and *O. Rheedei* Benth. & Hook. of South India are other species that flower annually and regularly and do not die down after flowering. It is very likely that several other species in India will have to be added to this class. Beans mentions that of the Japanese plant *Sasa auricoma* E. G. Camus a few culms flower at Kew every year and that the plant is not affected.[1]

Gregarious and Periodical Flowering.

In this case all stems of one clump and all clumps in one particular area flower at the same time. That area may be comparatively small or extend over hundreds of square miles. The leaves are shed and there is nothing left on the stem but one large panicle of flowers. After ripening their seed the culms die and with them, as a rule, also the rootstocks. The period which elapses between two gregarious flowerings is shorter or longer, but seems to be more or less regular for every species.

How to calculate the Length of Periods.

I take for an example a very common species of bamboo, *Bambusa arundinacea* Willd. The periodicity of flowering is very pronounced in this

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characterized by the following words :—'*Culmi foliiferi et floriferi distincti, quotannis florigerentes, hieme necati vere surculis progerminant.*' In this he is not correct. *A. falcata* flowers both sporadically and gregariously, and the other species do not flower annually.

[1] Troup (Silvicult. p. 981) makes mention of *Schizostachyum elegantissimum*, a Java plant, of which Kurz says that it flowers and dies every third year, reaching a height of 20-25 feet. I cannot put this species in any of the three classes. But this is not of much importance as *S. elegantissimum* is of very doubtful identity. Munro found in the herbarium some spathes with this note : '*Beesha elegantissima*, Kurz. *Caulibus tenuibus, gracillimis, altissimis, ramis terminalibus pendulis culmos truncosque arborum hosce sustinentes velantibus.*' Hassk. Pl. Jav. rar. 42 includes this species under the name of *Bambusa elegantissima* Hassk. and gives as locality 'Java, in *sylvis elatis*.' Then the species lay dormant till Gamble in his *Ind. Bambuseæ* (p. 114) revived it under *Schizostachyum tenue* Gamble. 'I cannot help thinking this (*S. tenue*) may be the plant described as *Schizostachyum elegantissimum*, Kurz in *Ind. For.* I 348 = *Bambusa elegantissima* Hassk. Pl. Jav. rar. 42 = *Beesha elegantissima* Kurz, Munro in Trans. Linn. Soc. xxvi. 146, but the specimens in the Calcutta Herbarium do not agree very well, and I have therefore preferred to describe it afresh. It is near *S. chilianthum*, but it is much more slender and has fewer heads, often reduced to 1 only.' Surely these are sufficient reasons for not identifying Kurz's species with *S. tenue*.

But here the story does not end. In 1908 Gamble described the new genus *Oreiostachys* in Proc. Roy. Acad. Amsterdam X (1908), 685. In the same place he published the new species *O. Pullei* Gamble. In 1913 Camus (Bambusées, p. 26) gives the following synonymy of *O. Pullei*: *O. elegantissima* (Kurz) Val.—*Beesha elegantissima* Kurz ?—*Schizostachyum elegantissimum* Kurz ?

Here we have another puzzle. Camus says that his plate 80, f. B. was drawn from a specimen sent to him from Buitenzorg under the name *Oreiostachys elegantissimum* (No. 63, Herb. Hort. Bog.). Apparently the Buitenzorg authorities considered their specimen to be identical with Kurz's plant. But why does Camus doubt it ? There is one point that shows that Kurz had a different plant before him and it is this : *Schizostachyum elegantissimum* Kurz flowered every third year, whilst *Oreiostachys Pullei* flowers rarely. Kurz's species is therefore neither *Schizostachyum tenue* Gamble nor *Oreiostachys Pullei* Gamble. *Sed quid est* ?

bamboo, though isolated clumps are found occasionally, some in the year previous to the flowering, and others in the year following.

Brandis has calculated that general flowering takes place in periods of 30–32 years, Gamble at intervals of 30 roughly, Troup of 32-34 years, Parker of 45 years. What is the meaning of these periods? it does not mean that the same clumps which have flowered together in one year continue growing for a certain period and flower again gregariously over a certain area. It was pointed out above that after gregarious flowering the stems and generally even the rootstock die down. The period, therefore, indicates at the same time the age of the species or its physiological life-cycle. As soon as the bamboo has flowered, the seeds begin to develop and in the year following start germinating. This is the beginning of the life-cycle of the new plant or of a new period. I invite the reader to look up *Bambusa arundinacea* in the list of Pt. I. About 18 records of flowering are put down as gregarious. About the rest I was not sure. Gregarious flowering took place in 1804, 1836, 1866, 1869, 1878, 1881, 1882, 1896, 1900, 1910, 1912, 1912-15, 1913, 1913–15, and after a recent note by Parker in 1926. It is evident that not all the records can be utilized for ascertaining the length of the period. The records must refer to the same area. It will not do v.g. to connect 1804 of the W. Coast of India with 1836 of Dehra Dun and to conclude from it that the period is 32 years, or 1862 of the W. Coast of India with 1896 of Coimbatore concluding that the period is 34 years. This method is wrong, though the result might, by chance, be correct.

Brandis utilized the following records made in one area, viz., Malabar, South Kanara, the Wynaad and Coorg : 1804, 1836 (not mentioned in my list) and 1866. The first two records give a period of 32 years, the second and third of 30 years. Then he takes two records from the Narbudda river: 1839 near Jubbulpore and 1870 at Jubbulpore. Result: a period of 31 years. Troup says that the period lasts 34 years, but he does not point out which data he utilized. I do not doubt the correctness of his records when he says that there were gregarious flowerings about 1874 to 1884, 'mainly in 1878' and 'about 1905 to 1918, chiefly 1912', all observed in Kanara, Belgaum and Dharwar. If we take those data which he qualifies as 'mainly' and 'chiefly', viz. 1878 and 1912, then the period must be 34 years. What he exactly means by 'about 1874 to 1884' and 'about 1905 to 1918' is not quite clear from his account; very likely he had more definite details about those years and the corresponding areas before him, otherwise he would not have mentioned them.

The flowering period would therefore be 30–34 years.

But then we have two records from Dehra Dun where a general flowering of this species was noted in 1836, 1881 and 1926, i.e., at an interval of 45 years. But before we accept this conclusion, it may be useful to remember that the bamboos of Dehra Dun were not a natural growth, but had been planted. How cultivated bamboos behave with regard to their flowering we shall see later on.

The question would now naturally arise whether one and the same species has different flowering periods in one and the same area, considering climatic conditions or, to put it more clearly: Can the climate influence the length of flowering periods? We shall come back to this question later on.

Bambusa arundinacea is a characteristic example of gregarious periodical flowering. We must not, however, think that between two gregarious flowerings it is never seen in flower. Occasionally we find isolated clumps in flower. It is not rare that a few clumps flower during the year preceding the general flowering and others during the year succeeding it.

Another phenomenon must be mentioned which has been observed in this and other species. Troup describes it in this way: 'In many cases it (the flowering) has been observed to commence in one locality and to spread like a wave in a definite direction, taking a few years to extend over the whole flowering area.' *Bambusa arundinacea* v.g. according to the same author began flowering in 1912 on plateau tracts of the Wynaad and spread southwards to Kollegal and Coimbatore where it ended in 1915. There are no records to show that in succeeding general flowerings the same wave-like progress over a greater area has occurred. We shall return to this point below.

There is no bamboo of which we possess more numerous and better records as to its flowering than *Bambusa arundinacea*, and still we have to admit that they are not quite satisfactory. If we wish to obtain reliable results,

we must have exact data for some particular district with uniform conditions of soil, rain, moisture, temperature, wind, exposure and elevation. If there are isolated flowerings preliminary to or following the general flowerings, the possible cause should be ascertained which under the above conditions are very likely to be found in the quality of the soil and its water-content in that particular spot where the flowering occurred. The other conditions, as they are supposed to be uniform, cannot vary so easily within a limited area.

Another point must not be overlooked. If an observer in his botanical rambles is on a sudden confronted with a general flowering, it is evident that he cannot know when the last flowering in that precise locality took place. But he cannot even be sure that all the bamboos he has before him are the result of the last general flowering. There are very few people who have seen two successive general flowerings of a long-lived bamboo. It is, therefore, not the individual who can be expected to make reliable observations on this point, but the Botanical and Forest Departments which, on account of their continuity, are in a position to start experiments and observations for a prolonged period.

OTHER SPECIES WITH CHARACTERISTIC PERIODIC FLOWERING

Bambusa polymorpha Munro has always been considered to flower at long intervals and the flowering itself as remarkably gregarious. After flowering the plants die. In 1899 Brandis writes: 'It may not, I fear, be possible to put together at the present time, a complete history of the flowering of *Bambusa polymorpha* in Pegu in 1859 and subsequent years.' As a matter of fact he had only a few records at his disposal and it was impossible to connect them in such a way as to enable him to draw a satisfactory conclusion.

When Troup states that in Prome it is reported to have flowered over an area of about 3 square miles in 1914, he adds: 'This is the first record of anything approaching gregarious flowering for about 55 years'. He evidently refers to the general flowerings of 1859 on the west side of the Pegu Yoma. Immediately afterwards he says that in 1918 there have been signs of an approaching general flowering on the west side of the Pegu Yoma and 'if this materializes' he continues, 'the life-cycle of the bamboo may be placed at about 60 years or a little more.' Here, too, Troup seems to connect the possible general flowering with that of 1859. It seems to me that the records of flowering of this species are too scanty and that especially the localities where general flowering has occurred are not sufficiently well defined to furnish an accurate conclusion. In some cases the information is not even definite. This applies to the gatherings of 1862 and 1871. I draw attention to what Brandis says: 'I am disposed to think that the specimens gathered in 1862 and 1871, must have come from clumps which had flowered out of their time.' After all they may have flowered in time.

Melocanna bambusoides Trin. is another species exhibiting gregarious and periodic flowering. The length of the period, according to Gamble, is about 30 years, according to Kurz 30–35 years, and according to Troup about 45 years. Our list in Pt. I yields almost any length of flowering period. The bamboo flowered in Chittagong and Arakan in 1863–1866 and again in 1901, 1902 and 1904 over restricted areas; the period, therefore, would be about 38 years. There was again an extensive flowering from 1908–12, therefore, a period of about 10 years. Arakan saw once more extensive flowering between 1910–13 and a gregarious flowering between 1915–16. If we connect this latter flowering with the big gregarious event of 1863–1866, the period reaches at least about 50 years. But if we take the flowering of 1908–12 and 1863–1866 in Chittagong we obtain Troup's period, i.e., 45 years. This seems to make it evident that the records are not sufficient for any definite conclusion. It is not enough to know that there was a gregarious or extensive flowering in a certain country or district and that after some time another extensive flowering took place in the same country or district. We have to know the exact area and without that important detail all our records and, consequently, all our conclusions, are vitiated.

This defect can be clearly illustrated by the following facts:—*Melocanna* flowered in the Garo Hills in 1889, in Assam in 1892, again in the Garo Hills from 1900-1902. (We are allowed to include Assam, as by Assam evidently the south-west corner of the Kamrup District is meant). We have, therefore, in the Garo Hills at least 3 flowerings during a period of about 12 years, and that

within a limited area. But we have no evidence to show which part of the area was affected in each case, nor can we ascertain, how far the flowering was general in the affected areas.

Irregularly Flowering Species

Brandis gives the following description of this class of bamboos :—' One or a few culms in one clump, or a few clumps in one locality, are in flower at any one time, while at other times all culms of one clump and all clumps in one district are simultaneously covered with flowers.' (*Ind. Trees*, 662). Some years earlier, Brandis expressed the same in the following words which bring out some points more clearly :—' Some [species] at times are found in flower over large areas and after a series of years they are found to flower again in the same locality. The same species, however, is also found to flower sporadically, and in such cases leaf-bearing stems are not rarely found in a flowering clump, and at times some of the flowering stems bear leaves.'

It comes to this that irregularly flowering species flower gregariously and periodically at apparently definite intervals and at the same time sporadically at shorter intervals. Logically considered, it is not a good class, because it is practically impossible to draw a sharp line between gregarious flowering on a smaller scale and sporadic flowering on a larger scale, because in nature the two merge into each other. We also know that some species exhibit a distinct tendency to produce flowers gregariously at long intervals and rarely sporadically, whilst other species show sporadical flowering almost every year and gregarious flowering occasionally. But where can we draw a definite line between the two? Still, for convenience's sake, I retain this class.

Some Types of Irregularly Flowering Bamboos

Dendrocalamus strictus Nees, a bamboo of very wide distribution, furnishes a good example of this kind of flowering. There seems to be no doubt that there are gregarious flowerings. Troup connects the general flowering of 1872–76 in the Garhwal outer Himalayan tract with that of 1908-13 in the same country and concludes the period to be 36–40 years. But how do we know that there was no gregarious flowering between the two dates in the same tract? And if there have been none, how can we find out that the second flowering took place on bamboos derived from the seeds of the first flowering? In a hilly country like the Garhwal outer Himalayan tract, there are possibilities of seed-dispersal which justify my question. My doubt about the complete absence of flowerings during the period above mentioned is founded on the following consideration :—*Dendrocalamus strictus* is the most common and most widely spread of the Indian bamboos, occurring throughout the greater part of India, except in Northern and Eastern Bengal and Assam. In the drier types of mixed forest in Burma it is common. In many parts of the Siwalik tract and outer Himalaya from the Punjab eastward to Nepal, it is abundant (Troup). It is common throughout the hills of the Eastern and Western Ghats and of Central and Southern India. It also extends to Singapore and Java.

Now of this bamboo we possess for the last 60 years about 35 records of gregarious flowering for the whole area occupied by this species, or roughly, one for two years. This is an extremely poor record when we consider that in every botanical region of India general flowering must take place at different times in different smaller areas. Of the Bombay Presidency we have one record, of the Central Provinces five, of the whole of Burma only nine.

If we take the latter records as they stand, we might connect for Tharrawaddy the years 1865, 1888, 1895, 1912 and 1913, with the results that there were flowering periods of 23, 7, 17 and 18 years. But then Tharrawaddy is a comparatively large area and we don't know where exactly gregarious flowering occurred. It is again the absence of definite information on the exact locality of flowering which makes it impossible to draw reliable conclusions.

In addition to gregarious flowering, we can observe in this bamboo sporadic flowering, i.e., isolated clumps or small groups of clumps are in flower almost every year.

According to Troup, gregarious flowering usually takes some years to complete, and is often progressing in a definite direction in successive years. Troup evidently considers this progressive flowering as one big gregarious flowering, instead of as many gregarious flowerings on a smaller scale as there

are years of records. This is one way of looking at things, and perhaps the correct one, and one which will very likely help us in the explanation of the periodicity later on ; but for ascertaining periods of flowering the separation of years with the area occupied by flowering bamboos during those years respectively will, I have no doubt, prove more advantageous.

To the same class of irregularly flowering species belong *Dendrocalamus Brandisii* Kurz, *D. longispathus* Kurz, *D. Hamiltonii* Nees & Arn. Of the last we have three records of gregarious flowering from the Ruby Mines Districts in Upper Burma 1910, 1911, 1914. How far did the gregarious flowering in each year extend ? We have no data to ascertain the periods of gregarious flowering. Hooker f. says that it flowers every year ; I suppose he means sporadically. Parker mentions that it flowers periodically at long intervals. Our records go back to 1894 only, too short a time to calculate long intervals, even if we had more data at our disposal. Of *Dendrocalamus Brandisii* Kurz, Brandis says that it flowers frequently, and according to Troup it flowers sporadically as well as gregariously. Period not known. *Dendrocalamus longispathus* behaves in the same way.

Cephalostachyum pergracile Munro, one of the commonest and most widely spread bamboos of Burma, flowers frequently and may be found flowering sporadically almost any year. Though we possess quite a number of records of gregarious flowering from 1859 up to 1917, there are not two data which we could connect for the purpose of measuring the periods.

Cephalostachyum capitatum Munro is a bamboo of the N. E. Himalaya and Assam. Gamble thinks that it 'appears to flower at very frequent intervals' as it has been recorded in Sikkim in 1848 ?, 1866, 1869, 1874, 1878, 1892, and in the Khasia Hills in 1830, 1835, 1850, 1871-72. All these dates refer to sporadic flowering. I cannot agree with Gamble when he thinks that these 11 records indicate flowering at 'very frequent intervals.' After all the area is a very extensive one and it has been explored during a period of over 60 years, by men who were known as able collectors and botanists—Griffith, Anderson, Clarke, King and Gammie. This gives for the whole about one record for 10 years over the whole area.

Of gregarious flowerings of this species we have only one record. The seeding happened in Gamble's own observation in 1874, 'when large tracts in the Chel and Neora valleys in British Bhutan covered with this species died off and became the scene of a great conflagration in the following year.'

Bambusa Tulda Roxb. is a native of Central and Eastern Bengal, Assam and Burma, and very commonly cultivated around the villages of Lower Bengal. Of this species the records[1] are fairly numerous but not sufficient to show whether the periods are long or short. As to sporadic flowering we have only the general statetment by Brandis : 'At times flowers gregariously, while at other times single clumps are in flower.' It is strange that amongst all the data of flowering there is not one recording a sporadic flowering, unless we call Troup's record of 1903-5 from Tharrawaddy a case of sporadic flowering. He characterizes it as a fairly extensive flowering in single clumps or groups of varying extent, and calls it gregarious flowering. Here we have a case where it is difficult to say whether it should go by the name of gregarious or sporadic flowering.

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[1] Troup says that Brandis [*Ind. For*, xxv (1899) 12] records various flowering years, but he is not certain if these refer to gregarious flowering or to years in which flowers were gathered. It seems to me there can be no doubt about the meaning of the records given by Brandis judging from the context. After giving a list of them he continues : 'Isolated clumps of this species, however, not rarely come into flower.' This evidently indicates an opposition of isolated or sporadic to gregarious flowering.

(*To be continued.*)

NOTES FROM AN EXPEDITION FOR *OVIS POLI*

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(*With two plates*)

The collection of a series of Great Pamir Sheep (*Ovis poli*) for exhibition and study purposes was one of the primary objects of the Morden-Clark Asiatic Expedition of the American Museum of Natural History, of which I was the leader, and of which James L. Clark, Assistant Director of the Museum was the other member. Mr. Clark and I left New York the latter part of January, 1926 and went to Srinagar, Kashmir, from where we started northward via the Gilgit Road.

For several years I had been working on plans for an expedition to the Pamirs and Central Asia, and during six months spent in Baltistan, Astor, Ladakh and Kashmir, I had made all possible inquiries regarding routes and seasons and the best localities in which to work. Replies to my inquiries had indicated, however, that for some ten or fifteen years there had been very few good specimens of Marco Polo's sheep brought out from the Pamirs. Opinions seemed to be divided as to the cause of the scarcity of these animals. Some said that an epidemic had decimated the once numerous herds, others that since the war, modern fire-arms in the hands of natives had caused a great thinning-out of the animals. Altogether the reports were very discouraging.

One thing, however, was noticeable. I was able to find no one who had been, for some years at least, inside the Russian border. All reports as to the numbers of sheep came from the Tagdumbash Pamir, the only portion of the range of *Ovis poli* at present available to sportsmen. It occurred to me that, were I able to obtain permission to operate in the Russian Pamirs, it might be that the sheep would be found in sufficient numbers to warrant a Museum expedition to collect a representative series. Through the courtesy of friends in India and in London, I was accorded permission to take my expedition from Kashmir directly northward through Gilgit and Hunza, and, after some negotiation with Moscow, I was also accorded special permission to enter and travel in the Russian Pamirs, which, of course, are normally strictly forbidden to foreigners.

A portion of our equipment, including arms and ammunition, sleeping bags, saddles and bridles, and most of our clothing, was taken with us from New York; tents and a few items of food we purchased in London, while the balance of our supplies we obtained from Cockburn's Agency in Srinagar. The Agency also engaged our Kashmiri staff, only one of whom needs special comment. Hassan Bat, our *Shikari,* had previously been to the Pamirs and to the Thian Shan Mountains and knew a quite useful amount of Turki. Although Hassan Bat had the usual Kashmiri failings, he served us very well.

Owing to the early season at which we were leaving Srinagar, we were requested by the Government to limit our transportation requirements to sixty coolies, as it was the planting season in the territories of Gilgit and Hunza. We took with us supplies for five months only, for after our work in the Pamirs, we expected to continue northward to the Thian Shan Mountains, collect ibex, roe-deer and such other animals as time permitted, and then push eastward to Hami, where by arrangement we were to meet Dr. Roy Chapman Andrews, Leader of the Central Asiatic Expeditions of the American Museum. With him we were to travel eastward across the Gobi Desert to China. It became necessary, however, due to Andrews' being held in Peking by the Civil War in China, for us to make our five months' supplies, eked out by what could be purchased in the bazaars of Kashgar and Urumchi, last until we reached the Trans-Siberian Railroad, just nine months after leaving Srinagar.

Travel over the Gilgit Road is so familiar to the readers of the *Journal of the Bombay Natural History Society* that there is no need of my enlarging upon the journey from Srinagar to the Mintaka Pass, except to say that we started from Bandipur on April 1st, and found heavy going over the Tragbal and Burzil Passes. Through the courtesy of Major Lock in Gilgit and Major Gillan at Kashgar, we made excellent time northward from Srinagar and crossed the Mintaka Pass on April 24th. In the Tagdumbash Pamir, snow conditions were much less severe than they had been found in the higher country near the Pass. Kirghiz encampments were found at Lupgoz and Mintaka Karaul, and from these we were able to obtain yaks for riding and transport. We were also able to use *yurts,* which are by far the most comfortable accommodation that I have ever used in the open. From Mintaka Karaul, we went to Peyik, and at that point turned from the Tagdumbash Pamir, by Peyik-jilga, to just below the foot of Peyik Pass, which there divides Chinese and Russian territory. We arrived at Peyik Pass on the 28th of April.

At our request, Major Gillan, the British Consul-General at Kashgar, had sent thirty ponies to meet us at Peyik, and eight of these we loaded with equipment which would not be needed in the Pamirs and sent them direct to Kashgar. The balance of the ponies we took with us, but found that due to the lack of forage at that season of the year, they had to be sent back to Kashgar.

On our way to Peyik, we were joined by a well-known character of the Tagdumbash Pamir, Nadir Beg, a Sarakoli from Tashkurgan,

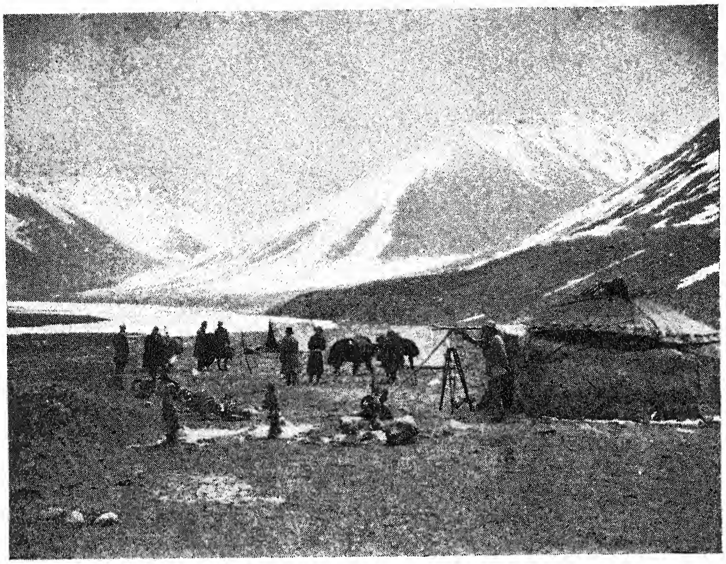
who has been with many shooting parties both in the Tagdumbash and on the Russian side of the border. Nadir Beg was with us during the entire month spent in the Pamirs, and was of the greatest assistance to us. From him and from other Sarakolis, we heard many tales regarding the treatment which travellers in the Russian territory might expect to receive. According to them, the best that we could hope for would be arrest, robbery and deportation. Although our credentials were of the best, we thought it wise to send a messenger ahead with our papers and to await his return on the Tagdumbash side of Peyik Pass. While waiting for him, we spent a few days looking for *Ovis poli* in Peyik-jilga, but though we saw old tracks and a few old heads, it was evident that sheep were very scarce, at least at that season.

Our messenger finally returned with word that we might go ahead, so we proceeded over Peyik Pass on April 30th. About ten miles inside the border we were met by a detachment of the Russian Border Patrol, who brought a letter of welcome from the commanding officer of Kizil Rabat Post. These chaps were very friendly, and appeared clean, well-disciplined and excellently equipped. The officer in command of the detachment told us that *yurts* had been prepared for our use some five miles down the valley, and we followed our escort to them. On our way down, thirteen *poli* rams were seen on a snow field high up on the side of a mountain. Examination through glasses and telescopes showed that one, at least, carried quite an excellent head. It was a comforting sight, for we had been a little discouraged at not finding recent signs of sheep in Peyik-jilga.

After a day at that camp, we followed our escort to Kizil Rabat Post, a small mud building with two or three *yurts* and a tiny compound, about thirty miles from Peyik Pass. We were told by the commanding officer at Kizil Rabat, after he had examined our credentials, that we were free to travel wherever we wished in the Pamirs, and that, if we desired, he would arrange for *yurts* to be placed at our disposal at each camp. This was done, and except for one camp which was simply an over-night stop, it was not necessary to use tents during the month we spent in the Pamirs.

From Kizil Rabat we returned to our first camp near Peyik Pass and spent several days in hunting, but snow still lay deeply in the mountains, which made the work exceedingly difficult. We saw several bands of rams, but no large heads were seen and as the deep snow made it impossible to travel far from camp during any one day's hunt, we moved camp beyond Kizil Rabat to a location locally known as Ak-Tsoi, on the edge of the Little Pamir. Although no specimens were collected here we were able to make some sketches and studies of *poli* by observing the animal through telescopes.

After two or three days we again moved camp to Dunggelduk, the local name for a narrow jilga which proved to be excellent sheep country. Around that section we saw many large bands of *poli*, and it was there that we obtained four mature rams for the collection. The largest of these measured 57½ inches around the curl, which was, with one or two exceptions, the largest we saw during our month in the Pamirs.



1.—Dung-Gelduk jilga, Russian Pamirs. Camp of the Morden-Clark Asiatic Expedition.

2.—William J. Morden and James Clark with escort of Russian Border Patrol from Kizil Rabat. (Morden *right*, Clark *left*.)

3.—Examining band of *Ovis poli* with telescopes, Russian Pamirs.

4.—*Ovis poli* ram shot by James Clark, Morden-Clark Expedition, American Museum of Natural History, Russian Pamirs, May, 1926. Curl $57\frac{1}{2}$ inches.

Previous to my work in the Pamirs, I had had considerable experience in sheep hunting, having shot seven varieties of wild sheep in North America and Asia. Before going to the Pamirs, I had made a careful study of the horns of *Ovis poli* so that I felt that I was able to judge, fairly accurately, their length when viewed through a telescope. Clark, also, was not a novice with sheep, as his position in the Museum and his private work as a taxidermist had brought him into contact with many different sheep heads from various parts of the world. It was our mature opinion that of the large number of *Ovis poli* rams which we examined through the telescope, none were appreciably larger than the ones which we collected.

From experience gained in measuring many old heads and from the study and observation of fully a thousand living animals and from the specimens which we collected, we came to the conclusion that at present the *average* length of adult *Ovis poli* horns is about 52 inches. That there are many with horns of greater length there can be no doubt, for we ourselves obtained five which measured from 55 inches to 57½ inches. It is quite possible, also, that a world's record head now ranges somewhere among the secluded valleys of the Pamirs, but we ourselves are quite positive that large heads are scarce at the present time. From our examination of old heads and those collected, it is our judgment that about 15 inches is the average base measurement of the heads of full-grown rams, although one or two of ours measured slightly over 16 inches, and there are records of base measurements of 17 inches.

Generally speaking, *Ovis poli* horns form an open spiral. This is particularly true in younger animals. Usually the horns form almost a complete circle and are not as 'nipped in' at the bottom of the first curl as is typical of the *Ovis ammon* of the Altai. There are exceptions to this rule, however. We saw several rams which carried horns of much the same type as those of *Ovis canadensis* of North America; others had the horns 'nipped in' close to the face with the wide flares typical of the Altai sheep.

Many rams with broken horns were observed during our hunting and observation. Frequently it was the right horn which was broken, though there seemed no good reason for it to be the right horn rather than the left. Often the broken stump appeared to be not much over a foot long and usually the break seemed clean and square. Horns which were broken at the top due to fighting were frequently seen; one ram with an otherwise beautiful head had the cores of both horns showing for several inches along the tops. Quite frequently the tips of the horns were broken or worn away, and nearly all of our large specimens would have been at least three inches longer had the tips been intact. Every adult male that we obtained had scars on the head due to fighting, and there were deeply rubbed spots on the front of each shoulder caused by the horns when the animal turned his head. In every specimen the hair on the back of the lower front legs was badly worn away from pawing through the snow.

Ovis poli are rather lightly built, and their bones seem very delicate for animals living in such rocky country. Neither are they exceptionally muscular, and the necks of the rams hardly seem

adequate for the carrying of such heavy heads. A carefully weighed large ram totalled 239 pounds. It must be remembered, however, that this was a spring weight, which in the fall would probably be increased by 25 to 50 pounds. All of the specimens which we collected were exceedingly thin and their ribs showed noticeably.

All the sheep collected by us were in excellent winter pelage and their heavy coats made them appear larger than they really were. Winter coats are shed about the end of May and this process was just beginning when we left the Pamirs. The coats on specimens collected in summer and early fall are short and differ somewhat from the winter pelage.

In early morning and at a distance, *poli* appear creamy white with light brownish saddles. Closer examination confirms this first impression, except that the white and the brown connect by an intermediate grayish tinge which blends the two and runs up the back of the neck. This gray fades out just behind the horns where the hair is almost white. The horns are yellow-white, something like the shade of old ivory. When the mirage of bright noon-day makes all objects at a distance indistinct, counter-shading will sometimes cause a band of *poli* to be almost invisible against slopes of broken rock, even when the animals are but two or three hundred yards away. Young lambs are a uniform dark gray, and this coloration seems to continue until after the first year, for yearlings, while lighter than lambs, are what might be termed a 'mouse-gray.'

Poli are infested with great numbers of parasites. All adult specimens collected by us had quantities of grubs under the skin; sometimes large areas, particularly along the back, would be perforated and the hair would be quite loose at those points. There were grubs also in the noses of many specimens and all were infested with ticks.

As is usual with wild sheep, in the spring-time the rams herd strictly by themselves. It was noticeable that the larger males usually kept together, though we saw a few bands which contained one or two immature rams of two or three years and we once saw a yearling with a number of full grown rams. Large herds of ewes and yearlings were common during early May, but about the 20th of the month, ewes became scarce and the yearlings were seen in groups by themselves or with one or two immature rams. We first saw new born lambs on the 24th of May and from then on in increasing numbers. Ewes undoubtedly seek secluded places among the peaks at lambing time, which would account for their scarcity on the lower levels at that season.

One morning we sighted a ewe from a distance and were attracted by her strange actions. She appeared lost, for she went uncertainly forward, gazed back, and then returned a little way, apparently to feed. It was only by careful use of the telescope that we finally distinguished the tiny dark form of a lamb stumbling along after its mother. Although the new born lambs were very wobbly for the first day or two, later when we tried to capture one of them we found that they attained surprising agility in a very few days.

During the summer, when it becomes quite hot in the middle of the day, there is a fair growth of grass over portions of the Pamir

region, but in the spring-time the diet of the *poli* is very limited. Tiny bunches of wiry grass grow here and there among the rocks, and about the middle of May a variety of wild onion makes its appearance in sandy areas. We saw sheep pawing through the sand to obtain the first shoots of the onions which had not yet reached the surface. This apparently forms a considerable portion of the spring forage of the *poli* and at that season the animals have a strong odour and their meat is richly flavoured.

After we had pretty thoroughly exhausted the possibilities of the region around Dung-gelduk, we moved to another, known locally as Kuzgun, and after a day or two there, to Ak-jilga, which we found to contain a larger number of sheep than any we had worked in previously. For ten days we covered the country on yaks and were able to complete the series with females, young and one or two other large rams. Almost everywhere we found Kirghiz camp sites, and around these were always many old *poli* heads. In fact, bleaching horns and skulls dotted the country everywhere. At first we thought that this great number of sheep had been killed by wolves or by severe winters. We learned, however, that the Kirghiz annually kill a considerable number of *poli* for their meat and hides. At the present time modern fire-arms are just making their appearance, but every camp contains one or more ancient home-made matchlock guns, and once or twice we were shown Russian breech-loading rifles. The usual method of hunting of the Kirghiz *shikaris* is to lie behind rocks or blinds while other members of the hunting party drive the sheep past the waiting guns. It would seem probable that in a few years, with modern fire-arms becoming more widely used, the herds of *Ovis poli* will be considerably decimated.

While it is, of course, impossible accurately to estimate the number of *Ovis poli* now ranging in the Pamirs, it is certain that their number is considerable. In the month that Clark and I hunted and travelled in the Russian Pamirs, we actually counted 1,052 rams and 607 ewes and young. These figures are on the conservative side, for we made generous allowances for possible duplications. Furthermore, in this number were included no animals we did not actually see and count ourselves. Several times, our *shikaris* told us of large herds which they had seen, but these we did not include in the total.

Roughly, the range of *Ovis poli* may be said to extend from the Thian Shan Mountains on the north, south through the Pamirs to the Valley of the Oxus, usually at an altitude of from twelve to eighteen thousand feet. In the Tagdumbash Pamir it would seem that they are now scarce. We were told by the Russians at Kizil Rabat Post that they extend on the west to the limits of the Pamirs. We, of course, though we covered considerable territory in actual area, saw but a small portion of their range.

Other large mammals of the Pamirs are ibex, wolves, foxes, snow-leopards and bears. Marmots are, of course, everywhere.

Ibex usually range among the higher and more rocky hills dividing the valleys, though once or twice we saw ibex low on the slopes not far from bands of *poli*. A few old ibex horns were seen

in various places, but not in the numbers that sheep heads were found. The Kirghiz do not kill many ibex, probably because the sheep are easier to get and their meat is better.

Wolves and foxes are common all over the Pamir region. We were told that wolves were very plentiful, particularly in the Great Pamir, where they were a pest. The single specimen which came under our observation was silvery gray and at a distance looked considerably smaller than the North American timber wolf. We saw many wolf tracks in fresh snow and some otherwise inexplicable movements of bands of *poli* were probably due to the unseen presence of wolves.

Red foxes were seen on several occasions; once I saw a red fox trying to kill a marmot. The two rolled down a rocky slope just ahead of me, and so far as I could see, the fox did not seem to be having much the better of the battle. I took a hurried shot at the moving mass which, although it missed, served to disentangle the two and the marmot dived among the rocks, seemingly little the worse for the encounter.

We saw no snow-leopards, although natives said that they were occasionally seen. A few tracks in the snow were the only evidences of their presence, but as they are almost entirely nocturnal, it is not surprising that we saw none.

One day, while watching a distant band of *poli* from a hillside, we saw a large bear with two cubs rapidly climbing a rocky slope some distance to our right. Before we could get a shot at them they were out of range, and although we followed as rapidly as possible to the ridge over which they had disappeared, there was no sign of the animals in the valley beyond. The old bear had looked large, with a heavy coat of fur much like that of a big 'silver-tip' grizzly. The Kirghiz told us that bears, although sometimes seen, are not common in the Pamirs. Those that we saw probably belonged to the *Ursus arctus* group, of which the Himalayan Brown Bear (*Ursus arctus isabellinus*), is a member.

I have purposely not given any day by day report of our experiences in hunting, for the actual hunting of *Ovis poli* is very similar to the hunting of other varieties of mountain sheep. The country is not unlike the *'ammon'* country of Rupshu in Ladakh, though altitudes, on the whole, average somewhat lower. Yaks are used for riding, of course, and are of the greatest assistance, for often long distances must be covered in a single day's hunting. Local guides may be obtained from various Kirghiz camps, but these *shikaris* are principally useful because they know the immediate terrain. They cannot be relied upon to judge the size of *Ovis poli* horns, for to them, as to the usual native *shikari*, every head is 'the best head'.

In conclusion I can only say that, if one is able to obtain a permit to enter the Russian Pamirs, a hunting trip for *Ovis poli* presents no unusual difficulties and is a thoroughly enjoyable experience.

REPORT ON A COLLECTION OF ANTS IN THE INDIAN MUSEUM, CALCUTTA[1]

BY

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(*With a plate and 6 text-figures*)

This report is based on a collection of ants received through the courtesy of Lieut.-Colonel R. B. Seymour Sewell, Director of the Zoological Survey of India, to whom my best thanks are due. The collection consists of 42 species representing five different sub-families. The majority of the collection is from the Himalayas, but there are a few specimens from the Palni Hills, South India, and from Calcutta. In the report besides recording several of the well-known older species I have included descriptions of six new species.

I have followed here Bingham's nomenclature as used in his volume on Hymenoptera in the Fauna of British India Series, and have given only a few of the synonyms of the species for the purpose of reference. The arrangement into different sub-families and tribes, however, is based on Emery's recent classification as expounded in the Genera Insectorum.

Sub-family: DORYLINÆ Leach.

Dorylus orientalis Westw.

1835. *Dorylus orientalis*, Westwood, *Proc. Zool. Soc. London*, v, p. 72.

1903. *Dorylus orientalis*, Bingham, *Faun. Brit. Ind., Hymenoptera*, ii, p. 4, fig. 7.

1910. *Dorylus* (*Alaopone*) *orientalis*, Emery, *Genera Insectorum, Hymenoptera*, p. 10.

This species, as was pointed out by Lefroy,[2] is subterranean in habits and attacks plants at their bases or roots. Workers of this species were found by Lancaster on Dahlias and on a fungoid pest of Larkspur in the Agri-Horticulture Garden, Alipore, Calcutta, while their nests in the earth under bricks and stones, were noted by Rothney[3] in Barrackpore. Wheeler[4] recorded many workers from Lobo (alt. 400 ft.) in rotten wood. The species has a wide distribution in India, Burma, and has also been recorded from the Malay Peninsula, Borneo, Sumatra and Java.

Sub-family: PONERINÆ Lepeletier.

TRIBE: ODONTOMACHINI Mayr.

Odontomachus punctulatus Forel.

1900. *Odontomachus monticola*, race *punctulatus*, Forel, *Journ. Bombay Nat. Hist. Soc.*, xii, p. 58.

1903. *Odontomachus punctulatus*, Bingham, *op. cit.*, p. 49, fig. 28.

The collection includes a single specimen of this species, which was collected by Dr. F. H. Gravely at Kalimpong (alt. 4,500 ft.), Darjeeling district, Eastern Himalayas. The species occurs also in Sikkim and Upper Burma.

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[1] Read before the Fifteenth Session of the Indian Science Congress held at Calcutta, 1928.

[2] Lefroy, H. M., *Indian Insect Life*, p. 227 (1909).

[3] Rothney, G. A., *Trans. Ent. Soc. London*, i, p. 109 (1903).

[4] Wheeler, W. M., *Rec. Ind. Mus.*, viii, p. 233 (1913).

Lobopelta diminuta Smith.

1857. *Ponera diminuta*, Smith, *Journ. Linn. Soc., London*, ii, p. 69.
1903. *Lobopelta diminuta*, Bingham, *op. cit.*, p. 61.
1911. *Lobopelta diminuta*, Emery, *op. cit.*, p. 103.

A nest of this species, containing eggs, larvæ, cocoons, males and workers, was found below the grasses in the College compound at Ballygunge, Calcutta. The eggs are minute and oval in shape. The larvæ are elongated and possess a long narrow and curved neck terminating in a head provided with mouth parts. The larvæ are enclosed within a thin chitinous integument bearing a number of tubercles and minute hairs. The cocoons are torpedo-shaped and covered with a tough, brown membrane.

The ants of this species have the habit of moving their camps from place to place. At the time of changing the nests the workers seize the larvæ and the cocoons in their mouth and remove them ; while the males follow the workers to their new home. The eggs owing to their minute size, cannot be carried like the larvæ from place to place, but owing to their sticking to the body of the larvæ, they are carried along with them.

The adult is black, while the colouration of the callows varies from yellowish brown to reddish brown. These ants, as has been pointed out by Rothney, march in long lines, two deep.

Several examples of the species were collected by the late Lord Carmichael from Singla, (alt. 1500 ft.), Darjeeling district. The species is common in Bengal and occurs throughout India with the exception of the Punjab and the dry desert portions of Central India; it has also been recorded from the Malayan region.

Lobopelta pequeti Er. André.

1887. *Lobopelta pequeti* E. Andréa, *Rev. d'Ent.*, vi, p. 292.
1903. *Lobopelta pequeti*, Bingham, *op. cit.*, p. 71, fig. 37.
1911. *Leptogenys (Lobopelta) pequeti*, Emery, *op. cit.*, p. 104.

These ants travel in files, two abreast. Wroughton[1] records that the species makes stridulatory sounds which are audible when the ear is placed close to them. Aitken observes also that sounds produced by the ants of this species are loud enough to be audible to the human ear. Bingham, however, doubts their ability to make any sounds, but I have observed that the sound is actually produced by the rubbing one against the other of the anterior and posterior portions of the gaster near its constriction.

TRIBE: PONERINI Forel.

Diacamma scalpratum (Smith).

1858. *Ponera scalpratum*, Smith, *Brit. Mus. Cat.*, vi, p. 84.
1903. *Diacamma scalpratum*, Bingham, *op. cit.*, p. 77, fig. 40.
1911. *Diacamma scalpratum*, Emery, *op. cit.*, p. 65.

Bingham records the species from Burma and Tenasserim; Long and Jewett found it in Assam, and Forel reports it from Sikkim. Examples of species were collected by the late Lord Carmichael at Sukna (alt. 100 ft.), Darjeeling district.

Diacamma vagans (Smith).

1861. *Ponera vagans*, Smith, *Journ. Linn. Soc. Zool. London*, v, p. 103.
1903. *Diacamma vagans*, Bingham, *op. cit.*, p. 81, fig. 43.
1911. *Diacamma vagans*, Emery, *op. cit.*, p. 67.

A colony of about 20 workers and a male was obtained during the month of July 1927 from a nest beneath a mango tree at Calcutta. The nest was composed of loose moist earth and was four or five inches deep. It is interesting to note that, although the nest contained larvæ and cocoons, no females were found in it. A few workers of *Platythyrea victoriæ* Forel, were, however found within the nest associated with the inmates, it is possible that they might have been 'thieve-ants'.

The species is very common in Bengal and is found throughout India, Burma, and Ceylon ; it has also been recorded from the Malayan sub-region.

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[1] Wroughton, R. C., *Journ. Bombay Nat. Hist. Soc.*, vii, p. 27 (1892).

Brachyponera luteipes (Mayr).

1862. *Ponera luteipes*, Mayr, *Verh. Zool-bot. Ges. Wien*, xii ; p. 722.
1903. *Brachyponera luteipes*, Bingham, *op. cit.*, p. 101.

The species is widely distributed in India. Specimens were collected by Dr. B.N. Chopra from Eagles Crag, Kurseong (alt. 5,000 ft.), Eastern Himalayas.

Sub-family : MYRMICINÆ Lepeletier.

TRIBE : PSEUDOMYRMINI Forel.

Sima rufonigra (Jerdon).

1851. *Eciton rufonigra*, Jerdon, *Madras Journ. Lit. Sci.*, xvii ; p. 111.
1903. *Sima rufonigra*, Bingham, *op. cit.*, p. 108.
1921. *Sima rufonigra*, Emery, *op. cit.*, p. 23.

The workers of this species differ from those of other Indian species of the genus in possessing ocelli and in having the 2nd node of the pedicel, the abdomen and the head black ; the thorax and the 1st joint of the pedicel vary in colour from light orange-yellow or orange-red to brick-red. A few specimens, however, collected in Calcutta with the typical workers were found to possess a second node that was concolorous with the first node and the thorax, the colouration being yellowish orange. In other individuals both the nodes are black like the abdomen, and in all other respects these examples resemble the typical form. On measuring those forms, which exhibited variation in the colour of the nodes, it was found that they were more or less of the same length. They occupied different nests, and it is, therefore, improbable that the difference in colour was due to age. I consider these forms to be simply varieties of the species. The species, including the varieties noted above, inhabits tree-trunks and tends Coccids. Their sting is severe and the pain caused by it lasts for several hours. In Calcutta they are always mimicked by the spider, *Salticus pataleoides* Camb. Sometimes they come into houses and attack honey, of which they are very fond.

S. rufonigra is distributed throughout the limits of India and the late Lord Carmichael obtained it at an altitude of 1,000 ft. at Sukna, Darjeeling district. It has also been reported from North-East Assam at Kobo (alt. 400 ft.).

TRIBE : PHEIDOLINI Emery.

Sub-tribe : Stenammini Ashmead emend Emery.

Aphænogaster smythiesi Forel.

1902. *Stenamma (Aphænogaster) smythiesi* Forel, *Rev. Suisse. Zool.*, x, p. 222.
1903. *Aphænogaster smythiesi*, Bingham, *op. cit.*, p. 276.
1921. *Aphænogaster (Attomyrma) smythiesi*, Emery, *op. cit.*, p. 59.

A. smythiesi has been recorded from the North-West Himalayas and from the East Himalayas area. I found specimens of it in the Indian Museum collection from Senchal (alt. 8,000 ft.) Darjeeling district.

Aphænogaster (Attomyrma) annandalei, sp. nov.

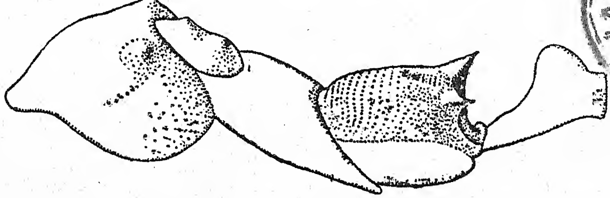


FIG. 1. *Aphænogaster (Attomyrma) annandelei*, sp. nov. × 30. Side view of the thorax and the first node.

WORKER.

Length, 8 mm., head oval, longer than broad, convex at the occiput, sides anteriorly straight, gradually narrowing posteriorly but not forming a neck; eyes small, round, placed a little in front of the middle of the sides of the head; mandibles triangular, with two apical teeth and masticatory border dentate; antennal carinæ convergent posteriorly; antennal and clypeal hollows deep and confluent; frontal area small, depressed; clypeus posteriorly produced between the bases of the antennæ, convex in the middle, its anterior border rounded; antennæ slender, the scape passing beyond the top of the head by about one-fourth of its length, joints of the flagellum longer than broad. Pronotum rounded on sides, convex above, anteriorly produced into a very short neck; pro-mesonotal suture distinct; mesonotum long, narrow, its anterior portion raised into an oval area as in *A. smythiesi* Forel, the posterior portion sloping back; meso-metanotal suture well marked; thorax emarginate at the latter suture; basal portion of the metanotum elongate anteriorly convex from side to side, the portion between the metanotal spines and just in front of them longitudinally excavated, apical portion slightly concave; metanotal spines short, acute and directed upwards; the first node petiolate, rounded above; the second node sub-conical and higher than the first; abdomen oval.

Mandibles punctate and longitudinally striate; the head feebly reticulate-rugose, anteriorly longitudinally striate; anterior basal portion of the metanotum distinctly striate transversely; nodes and abdomen smooth and shining.

A few erect hairs scattered on head and thorax; hairs more abundant on abdomen and nodes; pubescence absent.

Head and thorax dark reddish brown, mandibles yellowish brown, antennæ brownish yellow, legs pale yellow.

REMARKS.—The species is allied to *A. cristata* Forel, but is sharply marked off from the latter in having transverse striations on the metanotum and in the absence of a transverse medial impression in the mesonotum. Further, the head in this species is not constricted behind the eyes as in *A. cristata*. It differs from *A. smythiesi* in the outline of the head.

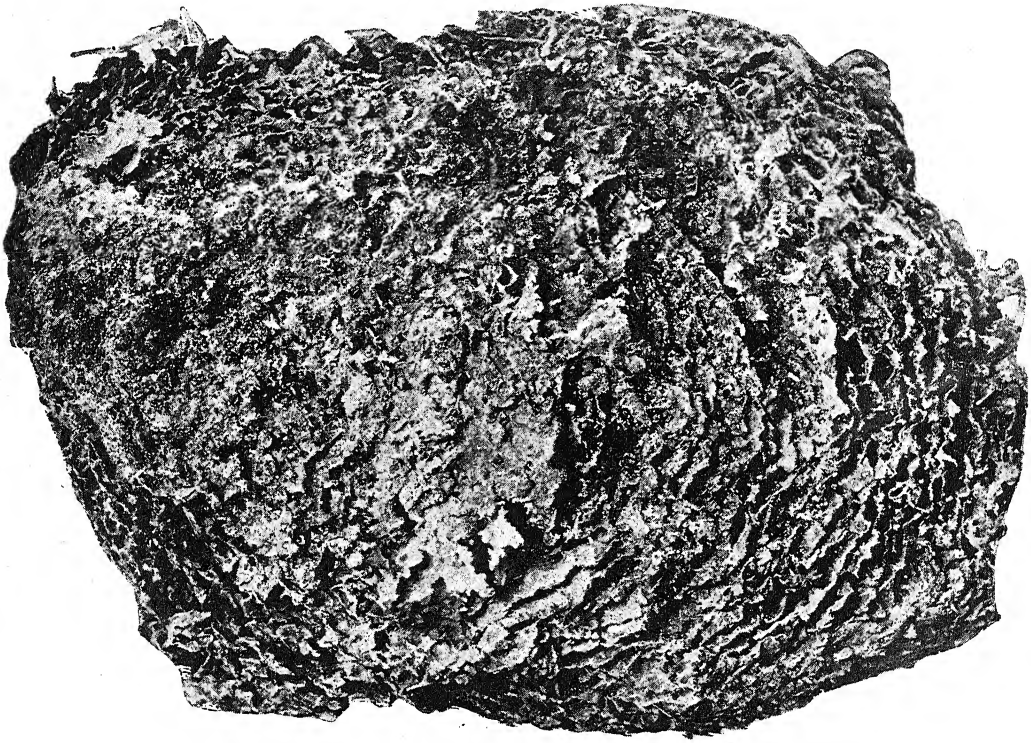
Types collected by the late Dr. N. Annandale from Simla (alt. 7,000 ft.) Western Himalayas, in the collection of the Zoological Survey of India, Indian Museum, Calcutta.

TRIBE: MYRMICARIINI Forel.

Myrmicaria brunnea Saunders.

1841. *Myrmicaria brunnea*, Saunders, *Trans. Ent. Soc. London*, iii, p. 57.
1903. *Myrmicaria brunnea*, Bingham, *op. cit.*, p. 118.
1922. *Myrmicaria brunnea*, Emery, *op. cit.*, p. 122.

Three nests of this species were found in the College compound, Ballygunge, Calcutta. The nests were situated at the bases of trees a few yards off a tank. The ground was soft, moist and shaded from the direct rays of the sun by the trees. The nests were tenanted by populous colonies including males, females and many hundreds of workers, and must have been in existence on the same spot for several years. Rothney noted a colony occupying a spot for twenty years. In the year 1927 during the rains I excavated a nest which occupied an area of approximately four square feet and was two feet in depth. The nest had a single outlet but had several galleries inside. In the furthest recesses of the nest, very near the chamber containing the ant larvæ, were located a few termites' nests. Each termite's nest contained a few termite workers and had a fungus garden in it. The galleries of the nests of these two distinct species were in communication with one another. The close proximity of the termites' nest to the larval chamber of the ants suggests the possibility that the ant-larvæ enjoyed the benefit of having food, in the form of termites, within easy access, and the termites, in their turn, enjoyed protection from other enemies owing to their being placed within the ants' nest. On the other hand, the possibility that the ant-larvæ derived benefit from the fungus garden cannot be ignored. As, however, the termitophagus habits of *M. brunnea* have not been observed and the fungus garden has not been found in other nests, it is not possible to lay down the exact relationships between these two species.



Nest of *Cremastogaster sorror* Forel.

An incident, which strongly bears out the termitophagus and predatory habits of *Lobopelta pequeti* and their behaviour towards *M. brunnea* may, however, be mentioned in this connection A few days after the excavation had been carried out, I observed that the nest, with the exception of a few workers, who vainly tried to rebuild it, had been deserted. In the meanwhile very near this nest a small colony of *Lobopelta pequeti* was seen to build a temporary nest, which was superficially covered over by grasses and contained their eggs, larvæ and cocoons. Some of the workers of *L. pequeti* had made their way into the demolished nest of *M. brunnea* and were found escaping from the nest with termites and larvæ of *M. brunnea* in their mouths. The workers of *L. pequeti* in this way carried out systematic depredations into the nests of *M. brunnea*. The peculiarity was that the latter apparently tolerated the presence of *L. pequeti*, and neither offered any resistance to them, nor made any counter reprisals on their enemies' nests, of the existence of which they were fully aware. It is clear from the behaviour of *M. brunnea* that this species is naturally timid and is not fond of termites as food, as otherwise they would have eaten them up long before the workers of *L. pequeti* made their appearance on the scene.

The species occurs in Bengal, Burma and Ceylon, and has been recorded from Borneo and Sumatra.

TRIBE: CREMATOGASTRINI Forel.

Cremastogaster subnuda Mayr.

1878. *Cremastogaster subnuda*, Mayr, *Verh. Zool-bot. Ges. Wien*, xxviii, pp. 680, 682.

1903. *Cremastogaster subnuda*, Bingham, *op. cit.*, p. 129.

1922. *Cremastogaster* (*Acrocœlia*) *brunnea* subsp. *subnuda*, Emery, *op. cit.*, p. 149.

Cremastogaster subnuda has been reported from different parts of India (except in the dry desert parts), Assam, Burma, Tenasserim and Ceylon. In the Indian Museum collection the species is represented by two specimens from Neutral Saddle (alt. 5,000 ft.), Palni Hills, South India, collected by Dr. S. W. Kemp on September 13, 1922.

Cremastogaster politula (Mayr.).

1902. *Cremastogaster subnuda* race *politula* Forel, *Rev. Suisse Zool.*, x, p. 207.

1903. *Cremastogaster politula*, Bingham, *op. cit.*, p. 131.

1922. *Cremastogaster* (*Acrocœlia*) *politula*, Emery, *op. cit.*, p. 150.

The species was found living in association with aphids on the plant *Lowsinia alba* at Ballygunge.

The distribution of the species is Bengal, Assam and Upper Burma.

Cremastogaster soror Forel.

1902. *Cremastogaster soror*, Forel, *Rev. Suisse Zool.*, x, p. 200.

1903. *Cremastogaster soror*, Bingham, *op. cit.*, p. 134.

1922. *Cremastogaster* (*Oxygyne*) *soror*, Emery, *op. cit.*, p. 157.

A big nest of this species was found on the trunk of the tree, *Grevillea robusta*, Cunn, at Ballygunge in the month of July, 1927. The nest was situated nearly 12 feet above the ground and was attached to one side of the stem. Its colour resembled so closely that of the tree that it was at first mistaken for the stump of a branch of the tree and it was only by following the ants that the nest was detected. The nest was made of a papery substance intermixed with vegetable fibres, clay and sand debris (Plate). Prof. Hans Molisch of Vienna, to whom I had the pleasure of sending a portion of the dried nest, kindly informed me that the nest was chiefly composed of a fungus. It contained an enormous number of galleries and had numerous exits in the form of pores on the side facing the tree trunk. Although the nest was exposed to the rain, the interior of the nest was perfectly dry and contained thousands of larvæ, nymphs and workers. It is of interest to note the difference in colouration between individuals of different ages. The callows are generally grey, while the adults are dark in colour. The workers were seen tending Coccids on the same tree, a little distance from the nest.

The distribution of the species is Western India, Poona, Bombay, Upper Burma and Northern Shan States. The species is also recorded from Calcutta.

TRIBE : SOLENOPSIDINI Forel emend Emery.

Subtribe : Monomoriini Emery.

Monomorium (Parholocomyrmex) kempi, sp. nov.

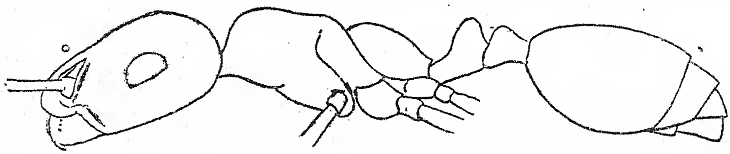


FIG. 2. *Monomorium (Parholocomyrmex) kempi*, sp. nov. × 30. Side view.

WORKER MAJOR.

Length, 3·5 mm., head rectangular, longer than broad, slightly emarginate at the occiput; eyes prominent, placed laterally at about the middle of the sides of the head, antennal carinæ short; clypeus bicarinate, anteriorly truncate, posteriorly produced between the bases of the antennæ; antennal and clypeal hollows confluent; mandibles toothed; antennæ 12-jointed, with a three-jointed club nearly as long as the rest of the flagellum; 1st and 2nd joints of the flagellum subequal, joints 2–7 smaller than the rest. Scape clavate extending beyond the top of the head. Thorax narrower than head; pronotum convex above, its angles rounded; promosonotal suture distinct; thorax emarginate at the meso-metanotal suture; metanotum slightly gibbous and without any teeth or spines. First node petiolate, sub-conical and raised higher than the second node; second node cuboid; abdomen elongate oval. Legs moderately long. Head punctate, a few obsolete striæ at its anterior end, rest of the body smooth, without any sculpture; body devoid of pubescence and hairs.

Head and nodes reddish brown; thorax yellowish brown; abdomen shining black with a metallic tint.

Worker Minor—smaller than the major worker, otherwise resembling it in all respects.

Described from several specimens collected by the late Dr. N. Annandale and Dr. S. W. Kemp from Seistan desert, Labi Baring at the bases of tamarish bushes.

Types in the collection of the Zoological Survey of India, Indian Museum, Calcutta.

Subtribe : Solenopsidinii (Forel) emend Emery.

Solenopsis geminata (Fabr.)

1804. *Atta geminata*, Fabricius, *Syst. Piez.*, p. 423.
1903. *Solenopsis geminata*, Bingham, *op. cit.*, p. 158., fig. 64.
1922. *Solenopsis geminata*, Emery, *op. cit.*, p. 197.

The species is very common in India. It nests in the earth in the open fields, and swarms several times from March to October.

Phidologiton diversus (Jerdon.).

1851. *Ocodoma diversus*, Jerdon, *Madras Journ. Lit. Sci.*, xvii, p. 109.
1903. *Phidologiton diversus*, Bingham, *op. cit.*, p. 162.
1922. *Phidologiton diversus*, Emery, *op. cit.*, p. 212.

The species has a wide distribution in India and Burma and extends as far as the Malayan region. A few specimens of it were collected by Dr. S.W. Kemp at the foot of Palni Hills, South India.

TRIBE : MERANOPLINI Emery.

Meranoplus bicolor (Guérin.).

1838. *Cryptocerus bicolor*, Guérin *Cuv. Iconogr. Régn. Anim. Ins.*, iii, p. 425.

1875. *Meranoplus bicolor*, Smith, *Trans. Ent. Soc. London*, i, p. 34.
1903. *Meranoplus bicolor*, Bingham, *op. cit.*, p. 168, fig. 66.
1922. *Meranoplus bicolor*, Emery, *op. cit.*, p. 228.

It is a common species in Bengal and nests in the earth. It is distributed throughout India and Burma and extends to the Malayan sub-region, but is absent from the dry plains of the North-Western Provinces, Punjab and Central India; a single worker has also been recorded from Sadiya, North-East Assam.

TRIBE: CATAULACINI Emery.

Cataulacus taprobanæ (Smith.)

1853. *Cataulacus taprobanæ*, Smith, *op. cit.*, p. 225.
1903. *Cataulacus taprobanæ*, Bingham, *op. cit.*, p. 123.
1922. *Cataulacus taprobanæ*, Emery, *op. cit.*, p. 299.

Two specimens of this species were obtained by Dr. B.N. Chopra from the bank of Mahanada River near Siliguri. This species has also been reported from Colombo, Kandy and Ceylon.

Sub-family DOLICHODERINÆ.

TRIBE: TAPINOMINI Emery.

Technomyrmex elatior (Mayr).

1902. *Technomyrmex mogdiliani*, Emery, race *elatior*, Forel, *Ann. Soc. Ent. Belg.*, xlvi, p. 293.
1903. *Technomyrmex elatior*, Bingham, *op. cit.*, p. 302.
1912. *Technomyrmex modiglianii*, Emery, *op. cit.*, p. 44.

Examples of the species were obtained from the base of leaf-fronds of Sago plants in Calcutta. It is also found in Assam, Bhamo, Upper Burma and Southern Shan States.

Engramma Forel.[1]

Engramma incisum, sp. nov.

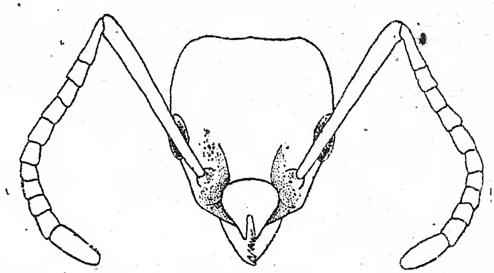


FIG. 3(*a*). Front view of its head.

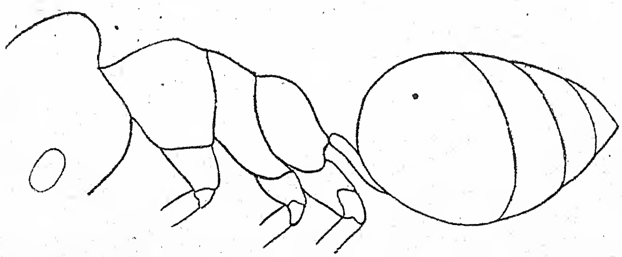


FIG. 3(*b*). *Engramma incisum*, sp. nov. × 30. Side view.

[1] Wheeler, W.M., *Bull. Americ. Mus. Nat. Hist.*, xlv, p. 201 (1922)

Head quadrate, nearly as broad as long, slightly emarginate behind, with the posterior end wider than the anterior. Eyes placed at about the middle of the head, round; anterior border of the clypeus distinctly incised in the middle.

Thorax arched, pronotum convex, elliptical in outline. Pro-mesonotal and meso-metanotal sutures distinct; thorax slightly emarginate at the meso-metanotal suture; basal portion of metanotum small, convex and passing by a gentle curve into the slanting apical portion. Abdomen overhanging the pedicel, punctured; pedicel without nodes.

Head, thorax and abdomen black. Legs dark reddish brown.

Types in the collection of the Zoological Survey of India, Indian Museum, Calcutta, collected by the late Dr. N. Annandale and Dr. S. W. Kemp in the Consulate Garden, Nasartabad, Seistan, in the months of November and December, 1918.

Sub-family: CAMPONOTINÆ Forel.

(*Formicinæ* Mayr in part; *Formicinæ* Lepeletier).

TRIBE: PLAGIOLEPIDINI Forel.

Acantholepis annandelei, sp. nov.

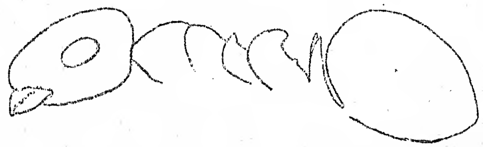


FIG. 4. *Acantholepis annandelei*, sp. nov. × 30. Its side view.

WORKER.

Length, 2 mm. Head sub-quadrate, nearly as long as broad; occiput not emarginate; antennal and clypeal hollows confluent; antennal carinæ sub-parallel, short; clypeus triangular, convex, carinate in the middle; antennae 11--jointed, the scapes extending beyond the posterior corners of the head by one-half their length; maxillary palpi 6-jointed; labial palpi 4-jointed; eyes prominent, about the middle of the head; ocelli present. Pronotum convex, circular in outline when viewed from above, pro-mesonotum viewed dorsally obvate; pro-mesonotal suture distinct; mesonotum convex from side to side, wider than long. Thorax deeply emarginate at the meso-metanotal suture. Scutellar region distinct and dorsally provided with two blunt tubercles. Basal portion of the metanotum with two short, stout, conical and blunt spines thick at the base and directed backwards and upwards; apical portion with small lateral blunt tubercles; node squamiform, shallowly emarginate at its upper surface and with two minute straight spines. Gaster broadly oval. Body black, abdomen shining, pubescence absent, with a few scattered erect hairs on the head and the posterior end of abdomen.

Types in the collection of the Zoological Survey of India, Indian Museum, Calcutta, collected by the late Dr. N. Annandale from Simla (alt. 7,000 ft.), Western Himalayas, on May 12 and 13, 1923.

Acantholepis frauenfeldi (Mayr).

1855. *Hypoclinea frauenfeldi*, Mayr, *op. cit.*, p. 378.
1894. *Acantholepis frauenfeldi*, Forel, *Journ. Bombay Nat. Hist. Soc.*, viii, pp. 411, 413.
1903. *Acantholepis frauenfeldi*, Bingham, *op. cit.*, p. 316.
1925. *Acantholepis frauenfeldi*, Emery, *op. cit.*, p. 25.

This species is chiefly confined to the hills but has also been found at Barrackpore, near Calcutta. The specimens under report are from Simla (alt. 7,000 ft.), Western Himalayas.

Plagiolepis longipes (Jerdon).

1851. *Formica longipes*, Jerdon, *op. cit.*, p. 122.
1894. *Plagiolepis longipes*, Forel, *op. cit.*, p. 414.
1903. *Plagiolepis longipes*, Bingham, *op. cit.*, p. 320, fig. 97.
1925. *Plagiolepis* (*Anoplolepsis*) *longipes*, Emery, *op. cit.*, p. 17.

The species is cosmopolitan in its distribution. It is believed that it has been disseminated by commerce throughout the tropical regions of the old world. It lives in nests tunnelled under stones, and is common in all parts of India except in the dry portions of the North-Western Provinces, Punjab and Central India. A single worker from Misty Hill, east side of Dawna Hills, was recorded in the results of the Abor expedition by Wheeler.

TRIBE: PRENOLEPIDINI Forel.

Prenolepis longicornis (Latr).

1802. *Formica longicornis*, Latreille, *Hist. Nat. Fourm.*, p. 113.
1894. *Prenolepis longicornis*, Forel, *op. cit.*, pp. 406, 407.
1903. *Prenolepis longicornis*, Bingham, *op. cit.*, p. 326.
1925. *Prenolepis* (*Paratrechina*) *longicornis*, Emery, *op. cit.*, p. 217.

The species is the common ant of Calcutta and lives in the crevices of the buildings. The workers may be found throughout the day prowling round food material and carrying away food to their nests. They generally change their nests following any sudden changes of weather, especially during the rains. When changing the nest, they move in columns with pupæ in their mouths and accompanied by the Gryllide *Myrmecophila prenolepidis*, a species of small beetle and the big female ants who have cast off their wings. This Myrmecophilous gryllid was observed by Assmuth at Bombay; but the Myrmecophilous beetle mentioned here has not been noted before in their company; unfortunately I have not been able to identify it. It is interesting to note that the beetle does not accompany the ants when they go out foraging. It lives within the nest of the ant but follows them spontaneously when the latter change their nest. Several beetles and *M. prenolepidis* occur in any colony of the ants.

The species is cosmopolitan in distribution and is quite common in Bengal and in other parts of India.

TRIBE: ŒCOPHYLLINI Forel.

Œcophylla smaragdina (Fabr).

1775. *Formica smaragdina*, Fabricius, *Syst. Ent.*, p. 828.
1894. *Œcophylla smaragdina*, Forel, *op. cit.*, p. 400.
1903. *Œcophylla smaragdina*, Bingham, *op. cit.*, p. 311.
1925. *Œcophylla smaragdina*, Emery, *op. cit.*, p. 52.

The ants of this species are very common on trees and shrubs in Bengal and also occur in other parts of India. They build nests of leaves fastened together by silk spun by their larvæ. They are gregarious in their habits, and often several colonies, each having a separate nest, may be found living amicably together on the same tree. The species is peculiar in having the females of the same nest differently coloured. The colourations vary from emerald-green to pale yellow.

They are partial to insect-food and the workers may be seen carrying living grubs and dead insects to their nests. A number of larvæ of moths and butterflies have also been found living in their nests. Often a group of both the mature and immature forms of the insect *Hilda bengalensis* Dist. (family *Fulgoridæ*), lives in association with these ants on the shoots of plants. The ants lick up the cellular secretion on the bodies of these insects and in return protect them. The ants of this species are much feared for their bites. In Calcutta it is mimicked by the spider *Amyciæa forticeps* (Cambr.), which was first observed by Ridley in Malaya in its company. The spiders have two prominent black spots on their abdomen and being of yellow colour simulate the appearance of the ants. The nature of the mimicry is also mentioned by Hingston.[1] Both male and female spiders occur on trees inhabited by the ants.

[1] Hingston, R. W. G., *Proc. Zool. Soc. London*, ii, pp. 844–848 (1927).

They move singly along, parallel with the marching columns of the ants, but keeping a little off their lines, possibly with the object of waylaying a solitary ant. While watching them, I observed a female spider with an ant caught between its limbs descending from a tree by hanging a line. When I put an ant and a spider together in a small collecting tube, the ant attacked the spider and caught it by its leg. The spider, however, warded off the attack with the help of its cheliceræ and ultimately entrapped its opponent by spinning a web round it.

The genus is confined to the tropical region of the old world and ranges over the Indo-Malayan, Papuan and Ethiopian regions but does not occur in Madagascar. *O. smaragdina* is widely distributed in India. Lord Carmichael's collection contains specimens from Singla (alt. 1,500 ft.), Darjeeling district. Wheeler (1913) also records three workers from Dibrugarh, North-East Assam, and Kobo (alt. 400 ft.) in the Abor country.

TRIBE: CAMPONOTINI Forel.

Group : DORYCUS—EXTENSUS.

Camponotus angusticollis (Jerdon).

1851. *Formica angusticollis*, Jerdon, *Madr. Journ. Lit. Sci.*, xvii, p. 120.
1892. *Camponotus angusticollis*, Forel, *op. cit.*, pp. 226, 235.
1903. *Camponotus angusticollis*, Bingham, *op. cit.*, p. 366, figs. 115, 116.
1925. *Camponotus angusticollis*, Emery, *op. cit.*, p. 89.

The species is black in colour and is known from Western and Central India, Assam and Burma. An example of this species was collected at Parambikulam (alt. 1,700–3,200 ft.), Cochin State, by Dr. F. H. Gravely in September 1914.

The species is a variable one, and the variety *sanguinolentus* Forel with yellowish red head and yellowish red thorax and black abdomen is recorded from Assam and Burma by Bingham. This variety is, however, not uncommon in other parts of India; specimens of this variety were collected at Kalimpong (alt. 600–4,500 ft.), Darjeeling district, Eastern Himalayas, by Dr. F. H. Gravely during the months of April and May, 1925.

Camponotus nicobarensis Mayr.

1865. *Camponotus nicobarensis*, Mayr, *Novara Reise. Formicid.*, p. 31.
1903. *Camponotus nicobarensis*, Bingham, *op. cit.*, p. 364.
1925. *Camponotus* (*Tenaemyrmex*) *nicobarensis*, Emery, *op. cit.*, p. 95.

The distribution of the species is Nicobars, Cochin-China, Burma and Assam. Lord Carmichael's collection includes specimens from Singla (alt. 1,500 ft.), Darjeeling district and Dr. F. H. Gravely obtained others from Kalimpong (alt. 500–4,500 ft.), Darjeeling district, Eastern Himalayas. Wheeler (1913) records many workers and a single dealated female from Kobo (alt. 400 ft.) under bark, Rotung (alt. 1,400 ft.) in dead bamboo and Dibrugarh, North-East Assam.

Camponotus mitis (Smith).

1858. *Formica mitis*, Smith, *Brit. Mus. Cat.*, vi, p. 20.
1892. *Camponotus maculatus* race *mitis*, Forel, *op. cit.*, pp. 230, 242.
1903. *Camponotus mitis*, Bingham, *op. cit.*, p. 355, figs. 112, 113.
1925. *Camponotus* (*Tanæmyrmex*) *variegatus*, Emery, *op. cit.*, p. 95.

The species has been recorded from different parts of India and Burma, and extends through the Indo-Malayan region to New Guinea. Several specimens were collected by the late Lord Carmichael at Simla (alt. 1,500 ft.) in 1913.

Group : COMPRESSUS—SYLVATICUS.

Camponotus compressus (Fabr).

1787. *Formica compressus*, Fabricius, *Mant. Ins.*, i, p. 307.
1903. *Camponotus compressus*, Bingham, *op. cit.*, p. 351, Fig. 109.
1925. *Camponotus* (*Tanæmyrmex*) *compressus*, Emery, *op. cit.*, p. 98.

The species occurs plentifully in Bengal and is also reported from other parts of India, Burma and Ceylon. It ranges from plains to mountains to an

altitude of about 7,000 feet. Like most of the widely distributed ants, it exhibits remarkable variations in colour and size and several sub-species and races have been recognised. The race *compressus* is black in colour, and is the common house ant in Calcutta. It dwells in the crevices of our buildings and lives upon our food. The same race may be found on trees feeding upon the products of ant-cattle, such as Coccids, Fulgorids and Membracids.

The individuals inhabiting trees generally nest in the soil round the roots of the tree, and form, like those living in our houses, big colonies. They swarm generally towards the evening in the months of June and July.

Two females of the species with enlarged abdomens were found living together in a common nest at the base of a palm tree. The nest contained also a few cocoons, but there was no food stored in it. The nest was situated a few inches below the ground and had no outlet. Apparently the ants together with the cocoons were living buried in the ground. The presence of the cocoons in the same nest is interesting, as it suggests the particular method adopted by the queen in founding a colony. It is probable that the queen would first rear a set of workers that hatch out of these cocoons, and these workers in turn would rear the following broods laid by the queen and help her in founding the colony. The association of two queens at the time of founding new colonies, in the same nest, is of special interest as such occurrence is seldom noticed.

A race which I cannot refer to any previously described form was found at the foot of Palni Hills (alt. 500–800 ft.), South India, by Dr. S. W. Kemp in 1922. I refrain from giving it a name as I am not definite of its being a distinct and undescribed race. I, however, give a description of it below :—

Camponotus compressus, a new race.

The head of the worker 18 mm. long, of this race differs from *Camponotus compressus* Fabr. in being rectangular in shape and in the absence of prominent occipital lobes. The scape extends greatly beyond the top of the head and is black in colouration except at its point of insertion to the head. The flagellum is long and castaneous. In other respects the head resembles that of *C. compressus.* The thorax is yellowish-brown and forms a regular arch as in *C. compressus.*

The abdomen differs from that of *C. compressus* in not having a shining appearance ; it is reddish-brown in colour, and each of its segments is shaded transversely with a fuscous tinge. The posterior margin of the abdominal segments is testaceous. The legs are long, prismatic and spined beneath. They are characterised by having the longitudinal edges of their dorsal surface raised above so as to form a longitudinal channel along the dorsal surface of each leg. The femur is honey yellow and tibiæ and tarsi yellowish brown.

Camponotus rufoglaucus (Jerdon).

1851. *Formica rufoglaucus*, Jerdon, *op. cit.*, p. 124.
1892. *Camponotus rufoglaucus*, Forel, *op cit.*, pp. 226, 237.
1903. *Camponotus rufoglaucus*, Bingham, *op. cit.*, p. 363.
1925. *Camponotus* (*Myrmoserisus*) *rufoglaucus*, Emery *op. cit.*, p. 105.

Camponotus rufoglaucus exhibits great variation in colour. In most forms the head is blood-red ; in a few, however, it is black. In all the forms the abdomen is pilose.

The species nests in ground and the workers forage singly on small shrubs.

The distribution of the species is Calcutta, Assam, Burma, Central India, Travancore and Ceylon.

Camponotus singularis (Smith). *Brit. Mus. Cat.*, *Hymenoptera*, vi, p. 27.

The ant described as *C. singularis* (Smith) is, as Bingham has shown, only a variety of *C. camelinus* (Smith). The head of the variety is blood-red in colour. Examples of this variety were collected from Kalimpong at altitudes varying from 600 to 4,500 feet, Eastern Himalayas and from Singla (alt. 1,500 ft.), Darjeeling district, by Dr. F. H. Gravely and the late Lord Carmichael respectively.

Camponotus sericeus (Fabr).

1798. *Formica sericeus*, Fabricius, *Ent. Syst. Suppl.*, p. 279.
1892. *Camponotus sericeus*, Forel, *op. cit.*, pp. 223, 231.
1903. *Camponotus sericeus*, Bingham, *op. cit.*, p. 376.
1925. *Camponotus* (*Orthonotomyrmex*) *sericeus*, Emery, *op. cit.*, p. 125.

The workers, having black sericeous bodies, are generally found in Calcutta during the rains. They nest in hard soil and form large, well populated colonies. The nest opens to the outside by a small circular aperture, the opening being flush with the ground. The interior of the nest could not be explored as earth loosened during digging choked up the hole of the nest and obliterated its view. The foraging habit of the workers is similar to that of *Prenelopis* (*Nylanderia*) *imparis* (Say), and their abdomen also becomes distended as in *P. imparis* owing to storage of honey in their crops.

A row of nests was discovered by the side of a road at Ballygunge, Calcutta. On the opposite side of the road nearly 30 feet from the nests, stood a *Ficus religiosa* with new leaves blossoming out. The workers coming out of the nests crossed the road and went up the tree trunk and its branches in search of food. On their return journey they made their way to their respective nests with all possible speed. Their abdomens were considerably distended, the scelerites of the abdomen being separated and the white intersegmental membranes exposed. During the return journey, if the head of a worker with the distended abdomen is gently pressed or their mandibles are drawn apart in an attempt to bite, a big drop of a clear transparent fluid with a sweet taste and smell runs out of their mouth. It is apparent that the liquid collected by them from the tree was meant for feeding others within the nest.

Two different forms of the species are found in Calcutta. In one the whole body is black and the abdomen is provided with a silky pubescence. In the second form, which is considered as a variety of the first, the head is blood-red in colour and the rest of the body black. Further, in this variety the posterior portion of the head and the protonotum are granular and the abdomen is devoid of the silky pubescence. The excavation of the posterior face of the metanotum of the variety is also slighty different from the type. The tibiæ and the antennæ of this variety are castaneous red. The rest of the characters are similar. Bingham reports the variety with the blood-red head from Burma and Ceylon. The species is fairly widely distributed over India and Burma.

Polyrachis thrinax Roger.

1863. *Polyrachis thrinax*, Roger, *Berlin. Ent. Zeit.*, vii, p. 152.
1893. *Polyrachis thrinax*, Forel, *op. cit.*, pp. 18, 28.
1903. *Polyrachis thrinax*, Bingham, *op. cit.*, p. 410, fig. 143.
1925. *Polyrachis* (*Myrmothrinax*) *thrinax*, Emery, *op. cit* , p. 183.

In the Indian Museum collection this species is represented from Calcutta.

Polyrachis armata (Le Guill).

1841. *Formica armata*, Le Guill, *Ann. Soc. Ent. France*, x, p. 313.
1903. *Polyrachis armata*, Bingham, *op. cit.*, p. 393, fig. 132.
1925. *Polyrachis* (*Myrmhopla*) *armata*, Emery, *op. cit.*, pp. 190, 192.

The distribution of the species is Assam, Burma extending to Borneo, Java and the Philippines. Individuals of this species is recorded from Singla (alt. 1,500 ft.), Darjeeling district, collected by the late Lord Carmichael.

Polyrachis simplex Mayr.

1862. *Polyrachis simplex*, Mayr, *op. cit.*, p. 682.
1903. *Polyrachis simplex*, Bingham, *op. cit.*, p. 394.
1925. *Polyrachis* (*Myrmhopla*) *simplex*, Emery, *op. cit.*, p. 196.

Several specimens and a nest, containing Coccids inside it were collected by Dr. F. H. Gravely from Durgapur Salt Lake in the vicinity of Calcutta. The nest consisting of a single chamber and made up of silky threads woven together was suspended on a tree. The species is widely distributed in India.

Polyrachis rastrata Emery.

1889. *Polyrachis rastrata*, Emery, *Ann. Mus.-Civ. Stor. Nat. Genova*, xxvii, p. 517.
1903. *Polyrachis rastrata*, Bingham, *op. cit.*, p. 412.
1925. *Polyrachis* (*Campomyrma*) *rastrata*, Emery, *op. cit.*, p. 179.

The species is known from Tenasserim, Dr. S. W. Kemp during the Abor expedition in 1911 obtained several workers of the species in association with Aphids from Dibrugarh.

Polyrachis mayri Roger.

1863. *Polyrachis mayri*, Roger, *Berlin Ent. Zeit.*, vi, p. 7.
1903. *Polyrachis mayri*, Bingham, *op. cit.*, p. 404, fig. 140.
1925. *Polyrachis* (*Myrma*) *mayri*, Emery, *op. cit.*, p. 29.

The distribution of the species is Bengal, Sikkim, Kanara, Travancore, Ceylon, Tenasserim and Burma. Lord Carmichael collected this species from Singla (alt. 1,500 ft.) Darjeeling district, and Wheeler in 1913 recorded several workers from Upper Rotung (alt. 2,000 ft.).

Polyrachis (*Myrma*) *hemiopticoides*, sp. nov.

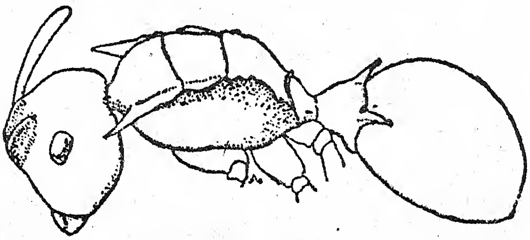


FIG. 5. *Polyrachis* (*Myrma*) *hemiopticoides*, sp. nov. × 11. Its side view.

WORKER.

Length 7 mm., head oval, convex above in the posterior region and wider behind; antennal carinæ prominent, long and sinuate; eyes prominent protruding, posteriorly slightly truncate, placed at the posterior third of the side of the head. The scape extending beyond the top of the head and nearly reaching the pro-mesonotal suture.

Lateral margins of the thorax sharply marginate, the sides of the thorax vertical. Thorax seen from the side forming a continuous flat arch. Pronotum wide, convex above and round, and on each side is provided with a long and acute spine lamelliform at its base, directed forward and outward and continuous behind with the lateral carinæ. The lateral carinæ projecting and notched at the pro-mesonotal sutures. Pro-mesonotal and meso-metanotal sutures distinct, mesonotum broader than long and unarmed with either spines or teeth. Basal portion of the metanotum convex, gently sloping down posteriorly, its postero-lateral corners with very small blunt tubercles; apical portion of metanotum concave.

The node of the pedicel trapeziform when viewed from above, its posterior lateral angles surmounted by spines, two very small teeth at the base of these spines on the outerwards.

Body jet-black, polished, highly shining; sparse hairs on the body. Gaster very minutely punctate, mandibles feebly striate. Femurs, trochanters, tibiæ, castaneous; whole of the tarsi and the extremities of the tibiæ and the femurs fuscous; flagella fuscous.

REMARKS:—The species closely resembles *Hemioptica aculeata* (Mayr.). It differs from the latter in having tarsi black and in the form of spines on the pronotum and in the absence of sericeous pubescence on the body.

Types in the collection of the Zoological Survey of India, Indian Museum, Calcutta, collected in Calcutta by the late Mr. C. A. Paiva, Entomological Assistant, Zoological section of the Indian Museum.

TRIBE: LASIINI Ashmead emend Emery.

Myrmecocystus setipes (Forel.).

1894. *Myrmecocystus viaticus Fabr* race *setipes*, Forel, *op. cit.*, p. 401.
1905. *Myrmecocystus setipes*, Bingham, *op. cit.*, p. 312, fig. 94.
1925. *Myrmecocystus* (*Cataglypus*) *viaticus*, Emery, *op. cit.*, p. 266.

The American representatives of the genus are known as honey ants; the workers which store up honey in their crops and act in this way as living store-houses of the colony, have their abdomens inflated and are known as repletes. The Indian species is so far not known to form any replete workers and they generally feed upon vegetable seeds and dead insects. The distribution of the species in India is interesting. The species is reported by Rothney [1] as not occurring in Bengal but is found in Bihar, the United Provinces and the Punjab. The species though rare in Bengal is not altogether absent. I have collected it at Krishnagar, Bengal. It extends westwards from the Punjab into Persia; a few specimens were collected in Seistan by the late Dr. N. Annandale and Dr. S. W. Kemp. In Bengal, however, as pointed out by Rothney, *Camponotus compressus* is the prevailing form, but in Bihar and Oudh this species becomes rare and is replaced by *M. setipes*. The crater nests of the species are found in hard soil and extend deep down in the ground. Two of such nests were observed in Madhupur to be situated very near one another.

TRIBE: FORMICINI Forel.

Formica gravelyi, sp. nov.

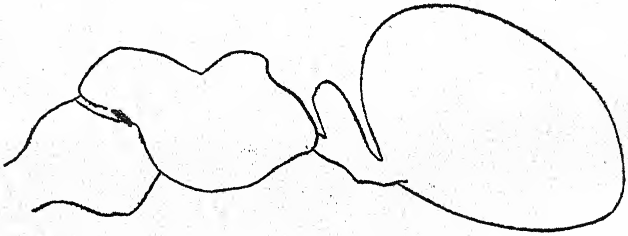


FIG. 6 *a*. *Formica gravelyi*, sp. nov. × 30. The side view of its thorax and abdomen.

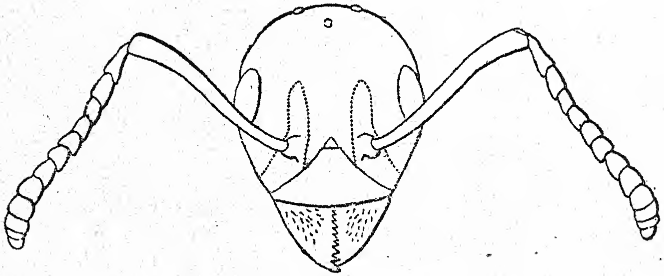


FIG. 6 *b*. Front view of its head.

WORKER.

Length, 4 mm. Head a little longer than broad, somewhat convex above, slightly emarginate behind; eyes placed at about the middle of the sides of the head, ocelli, present; clypeus triangular, convex in the middle and its anterior margin transverse; antennal carinæ short and parallel; antennal and clypeal hollows confluent; antennae 12-jointed, first and second joints subequal, and larger than the rest, the scapes slightly sinuately curved and

[1] Rothney, G., *Trans. Ent. Soc. London*, iii, p. 347 (1889).

extending just beyond the top of the head, flagella longer than the scapes; maxillary palpi 6-jointed, the 4th joint a little longer than the 5th; labial palpi with four joints; mandibles triangular, masticatory margin serrated, apical teeth very small. Pronotum broad and flat above, a little narrower than the head, anteriorly produced into a short flat neck. Pro-mesonotal suture distinct. Mesonotum convex and a little raised above the rest of the thorax and circular in outline; scuteller region distinct but depressed; thorax emarginate at the meso-metanotal suture; basal portion of metanotum slightly convex, apical portion slightly concave in the middle. Node flattened and inclined forwards. Abdomen sub-globose.

Head faintly punctate, neck minutely transversely striated, body smooth and glabrous. Thorax, antennæ yellowish brown, head a shade darker. Abdomen dark brown and covered with silky pubescence; sparse erect hairs on the body, pilosity abundant on flagella.

Types in the collection of the Zoological Survey of India, Indian Museum, Calcutta, collected by Dr. F. H. Gravely on a tree in the Zoological Garden, Calcutta. As the species is rare in Calcutta, I think the specimens described above were probably imported into Calcutta.

ON THE FISHES OF THE MANCHAR LAKE (SIND).

BY

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Mr. Salim A. Ali[1] recently published a fairly detailed account of the topography, etc., of the Manchar Lake in Sind, and in his account included short notes on the peculiar methods of fishing and fowling as practised in the lake; he also published a list of the birds observed by him in this interesting freshwater area. A party of the Zoological Survey of India consisting of Dr. B. N. Chopra, the senior author of this paper, Mr. R. A. Hodgart, Zoological collector, and an Entomological assistant spent about three weeks in November, 1927, surveying the lake and the surrounding area from the point of view of its freshwater fauna, and the following short paper deals with the species of fish collected or observed by the party.

In view of the recent paper by Mr. Ali cited above, it is not necessary to go into details about the topography of the area, but since the author in his account mentions only three species of fish from the lake, and as the fisheries of the area are of great importance—thousands of maunds of fish are caught and exported to all parts of the Punjab, Sind and Baluchistan every cold weather—we have thought it desirable to publish this paper on the different species observed or collected by the party

Hume[2] is the only author, who has, so far as we can find, referred to the importance of the fisheries of the lake. He 'estimated the weight of the fish taken in a single "drive" at a ton. The biggest were "huge siluroids" six or seven feet in length.' This statement is not strictly correct, as the catches now a days are not so large, and in addition to the cat-fishes a very large quantity of Cyprinoids of the species mentioned below, are caught in the lake every year. The Cyprinoids, from the point of their value, are certainly of far greater importance to the fishermen and the *Dumra—Labeo rohita* (Ham. Buch.) is one of the most highly prized fish. None of the Siluroids in the lake during the survey of the area were found to exceed a length of 4 feet.

List of fishes obtained from the Manchar Lake.

1. *Saccobranchus fossilis* (Bloch.).
2. *Wallago attu* (Bl. Schn.).
3. *Eutropiichthys vacha* (Ham. Buch.).
4. *Callichrous bimaculatus* (Bloch.).
5. *Pseudeutropius garua* (Ham. Buch.).
6. *Aoria aor* (Ham. Buch.).
7. *Aoria cavasius* (Ham. Buch.).
8. *Aoria vittatus* (Bloch.).
9. *Labeo calbasu* (Ham. Buch.).
10. *Labeo gonius* (Ham. Buch.).
11. *Labeo rohita* (Ham. Buch.).
12. *Cirrhina mrigala* (Ham. Buch.).
13. *Cirrhina reba* (Ham. Buch.).
14. *Catla catla* (Ham. Buch.).
15. *Barbus sarana* (Ham. Buch.).
16. *Barbus conchonius* (Ham. Buch.).
17. *Barbus phutunio* (Ham. Buch.).
18. *Barbus sophore* (Ham. Buch.).
19. *Rohtee alfrediana* (Cuv. & Val.).
20. *Chela gora* (Ham. Buch.).
21. *Chela punjabensis* Day.
22. *Chela bacaila* (Ham. Buch.).
23. *Gudusia chapra* (Ham. Buch.).
24. *Hilsa ilisha* (Ham. Buch.).
25. *Notopterus notopterus* (Pallas).
26. *Notopterus chitala* (Ham. Buch.).
27. *Xenentodon cancila* (Ham. Buch.).
28. *Ambassis ranga* (Ham. Buch.).

[1] Ali, Salim A., *Journ. Bombay Nat. Hist. Soc.*, xxxii, pp. 460–471 (1928).
[2] *Vide* Gazetteer of the Province of Sind, B Volume iv, Larkana District, by J. W. Smyth, p. 6. (1919).

29. *Ambassis baculis* (Ham. Buch.).
30. *Glossogobius giuris* (Ham. Buch.).
31. *Mastacembelus pancalus* (Ham. Buch.).
32. *Mastacembelus armatus* (Lacép.).
33. *Ophicephalus striatus* Bloch.
34. *Ophicephalus punctatus* Bloch.
35. *Trichogaster lalius* (Ham. Buch.).

As will be seen from this list, none of the species is new and all of them have a more or less wide distribution all over India. The following ten families are represented in the area:—Siluridæ (8 species), Cyprinidæ (14 species) Clupeidæ (2 species), Notopteridæ (2 species), Belonidæ (1 species), Percidæ (2 species), Gobiidæ (1 species), Mastacembelidæ (2 species), Ophicephalidæ (2 species) and Anabantidæ (1 species). The families Siluridæ and Cyprinidæ are best represented in the lake and some of the members of these two families grow to a fairly large size. The species which deserve a special mention in this connection are *Wallago attu* (Bloch. Schn.), *Aoria aor* (Ham. Buch.), *Aoria cavasius* (Ham. Buch.), *Labeo gonius* (Ham. Buch.), *Labeo rohita* (Ham. Buch)., *Cirrhina mrigala* (Ham. Buch.) and *Notopterus chitala* (Ham. Buch.).

Family Siluridæ.

Saccobranchus fossilis (Bloch).

1794. *Silurus fossilis*, Bloch, *Nat. Ausl. Fische*, VIII, p. 46, pl. ccclxx, fig. 2.
1889. *Saccobranchus fossilis*, Day, *Faun. Brit. Ind., Fish.* I, p. 126, fig. 53.

This species is represented in the collection by three young specimens, the largest of which is 100 mm. long.

Wallago attu (Bl. Schn.).

1801. *Silurus attu*, Bloch & Schneider, *Syst. Ichth.*, p. 378.
1889. *Wallago attu*, Day, *Faun. Brit. Ind., Fish.*, I, p. 126, fig. 54.

A single specimen of this species, 270 mm. long, was collected from the Manchar Lake.

Eutropiichthys vacha (Ham. Buch.).

1822. *Pimelodus vacha*, Hamilton Buchanan, *Fish. Ganges*, pp. 196, 379, pl. xix, fig. 64.
1889. *Eutropiichthys vacha*, Day, *Faun. Brit. Ind., Fish.*, I, p. 128, fig. 55.

This species is represented in the collection by two specimens of about 140 mm. length.

As we have recently pointed out [1] there appear to be two distinct varieties of *E. vacha*, one in which the snout is sharp and pointed, and the other in which it is blunt and rounded. The specimens from the Manchar Lake have a pointed snout.

Callichrous bimaculatus (Bloch.).

1794. *Silurus bimaculatus*, Bloch, *Nat. Ausl. Fische*, VIII, p. 24.
1889. *Callichrous bimaculatus*, Day, *Faun. Brit. Ind.*, *Fish*, I, p. 131, fig. 57.

C. *bimaculatus* is fairly common in the fresh waters of Sind and occurs in the Manchar Lake in large numbers. Seven specimens were collected, the largest of which is 160 mm. long.

Pseudeutropius garua (Ham. Buch.).

1822. *Silurus garua*, Hamilton Buchanan, *Fish. Ganges*, pp. 156, 375 pl. xxi, fig. 50.
1889. *Pseudeutropius garua*, Day, *Faun. Brit Ind. Fish*, I, p. 141.

The species is represented in the collection by four specimens, the largest of which is 185 mm. long.

Aoria aor (Ham. Buch.).

1822. *Pimelodus aor*, Hamilton Buchanan, *Fish. Ganges*, pp. 205, 379, pl. xx, fig. 68.

[1] Prashad & Mukerji, *Rec. Ind. Mus.*, xxxi, p. 176 (1929).

1889. *Macrones aor*, Day, *Faun. Brit. Ind.*, *Fish*, I, p. 149.

Two specimens of this species were collected from the lake; the larger of the two is well over a foot in length.

Aoria cavasius (Ham. Buch.).

1822. *Pimelodus cavasius*, Hamilton Buchanan, *Fish. Ganges*, pp. 203, 379, pl. xi, fig. 67.

1889. *Macrones cavasius*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 155.

The maxillary barbels extend up to or even beyond the middle of the caudal fin. In addition to the usual black spot covering the basal bone of the dorsal fin, there is also a blackish spot behind the operculum. The maxillary barbels are dusky above.

This species is quite common in the Manchar Lake and a good series of it was collected. The largest specimen in the collection is 155 mm. long.

Aoria vittatus (Bloch.).

1794. *Silurus vittatus*, Bloch, *Nat. Ausl. Fische*, v, p. 50.

1889. *Macrones vittatus*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 157.

The maxillary barbels extend as far as the middle of the anal fin and in some specimens even to the base of the caudal; they are blackish in colour. The adipose dorsal fin, in a specimen 90 mm. long, commences immediately behind the rayed dorsal and is three times as long as the base of the latter, while in younger specimens it is not more than twice the length of the base.

Eight specimens of different sizes were collected from the lake.

Family CYPRINIDÆ.

Labeo calbasu (Ham. Buch.).

1822. *Cyprinus calbasu*, Hamilton Buchanan, *Fish. Ganges*, pp. 297, 307, pl. ii, fig. 33.

1889. *Labeo calbasu*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 259, fig. 93.

This species is represented in the collection by five young specimens, the largest of which is 150 mm. long.

Labeo gonius (Ham. Buch.).

1822. *Cyprinus gonius*, Hamilton Buchanan, *Fish. Ganges*, pp. 292, 387, pl. iv, fig. 82.

1889. *Labeo gonius*, Day, *Faun. Brit. Ind.*, *Fish*, I, p. 261.

Five specimens of this species were collected from the lake. The largest of the series is 250 mm. long.

Labeo rohita (Ham. Buch.).

1822. *Cyprinus rohita*, Hamilton Buchanan, *Fish. Ganges*, pp. 301, 388, pl. xxxvi, fig. 85.

1889. *Labeo rohita*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 262.

Five specimens of this species were collected from the lake. The largest of the series is 235 mm. long.

Cirrhina mrigala (Ham. Buch.).

1822. *Cyprinus mrigala*, Hamilton Buchanan, *Fish. Ganges*, pp. 279, 386, pl. vi, fig. 79.

1889. *Cirrhina mrigala*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 278.

Three specimens of this species were collected from the lake. The largest individual is 280 mm. long.

Cirrhina reba (Ham. Buch.).

1822. *Cyprinus reba*, Hamilton Buchanan, *Fish. Ganges*, pp. 280, 386.

1889. *Cirrhina reba*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 279, fig. 96.

A pair of short rostral barbels are present. Five specimens which vary from 115 to 124 mm in length, were collected from the lake.

Catla catla (Ham. Buch.).

1822. *Cyprinus catla*, Hamilton Buchanan, *Fish. Ganges*, pp. 287, 387, pl. xiii, fig. 81.

1889. *Catla buchanani*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 287, fig. 99.

Two specimens of the species were brought back by the Survey party. None of the specimens is more than 230 mm. long.

Barbus sarana (Ham. Buch.).

1822. *Cyprinus sarana*, Hamilton Buchanan, *Fish. Ganges*, pp. 307, 388.
1889. *Barbus sarana*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 300.

In young individuals there is a faint blackish blotch near the base of the caudal fin, and another blackish mark is present behind the operculum, both in the young and adult individuals. The number of scales between the lateral line and the base of the ventral fins is $4\frac{1}{2}$.

This species is very common in the Manchar Lake and a large series of specimens of different sizes was collected. The largest specimen from the lake in the collection is 235 mm. long.

Barbus conchonius (Ham. Buch.).

1822. *Cyprinus conchonius*, Hamilton Buchanan, *Fish. Ganges*. pp. 317, 389.
1889. *Barbus conchonius*, Day, *Faun. Brit. Ind.*, *Fish*, I, p. 325.

Two specimens, about 35 mm. long, were collected from the lake.

Barbus phutunio (Ham. Buch.).

1822. *Cyprinus phutunio*, Hamilton Buchanan, *Fish. Ganges*, pp. 319, 390.
1889. *Barbus phutunio*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 327.

Two specimens, the length of which is about 35 mm., were taken at the lake.

Barbus sophore (Ham. Buch.).

1822. *Cyprinus stigma*, Hamilton Buchanan, *Fish. Ganges*, pp. 310, 389, pl. xix, fig. 86.
1889. *Barbus sophore*, Day, *Faun. Brit. Ind.*, *Fish.* I, p. 329.

A large series of specimens of this fish was collected. In all the specimens examined the barbels are entirely absent. The largest individual of the series is 75 mm. long.

Rohtee alfrediana (Cuv. & Val.).

1844. *Leuciscus Duvaucelii*, Cuvier & Valenciennes, *Hist. Nat. Poisson*, XVII, p. 77, pl. 491.
1889. *Rohtee cotio* var. *alfrediana*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 341, fig. 109.

A large number of specimens, varying in length from 65–75 mm., was collected from the lake. All the specimens have a faint blackish blotch behind the operculum.

Chela gora (Ham. Buch.).

1822. *Cyprinus gora*, Hamilton Buchanan, *Fish. Ganges*, pp. 263, 384.
1889.. *Chela gora*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 362.

A single specimen, 145 mm. long, was collected from the lake. In this specimen the lateral line is interrupted above and slightly posterior to the middle of the pectoral fins. We have examined Day's specimens from Sind and several others from different localities in the collection of the Indian Museum, and find that in the majority of cases the lateral line is similarly interrupted. It is of interest to note that in specimens about 130-170 mm. long, the suborbital bones are narrower than or equal to the orbital width ; it is only in considerably larger specimens that they are slightly " broader than the diameter of the eye " (Day).

The colouration of the specimen preserved in spirit is uniformly silvery except for the dorsum, which is blackish.

Chela punjabensis Day.

1872. *Chela punjabensis*, Day, *Journ. Asiat. Soc. Bengal*, XLI (2), p. 25.
1889. *Chela punjabensis*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 365.

A large series of specimens was collected from the lake. The colouration of the specimens in spirit is silvery with a distinct bright silvery lateral band. The dorsum including the snout is mottled with fine dark spots. The specimens are not more than 40 mm. long.

Chela bacaila (Ham. Buch.).

1822. *Cyprinus bacaila*, Hamilton Buchanan, *Fish. Ganges*, pp. 265, 384, pl. viii, fig. 76.
1889. *Chela bacaila*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 367.

The species is represented in the collection by six specimens, the largest of which is 110 mm. long. The number of rays in the anal fin in Sind specimens, according to Day, is "A. 2/11-12", but in all the specimens from the Manchar Lake there are three simple and twelve branched rays in the anal fin. The symphysis of the lower jaw is tipped with black.

Family Clupeidæ.

Gudusia[1] chapra (Ham. Buch.).

1822. *Clupanodon chapra*, Hamilton Buchanan, *Fish. Ganges*, pp. 248, 383.
1889. *Clupea chapra*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 375.

A large series was collected from the lake. In some specimens a single blackish humeral spot is present, in others it is followed by a series, while in many such spots are entirely absent. The largest individual in the collection is 150 mm. long.

Hilsa[2] ilisha (Ham. Buch.).

1822. *Clupanodon ilisha*, Hamilton Buchanan, *Fish. Ganges*, pp. 243, 382, pl. xix, fig. 73.
1889. *Clupea ilisha*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 376, fig. 115.

This fish which ascends the Indus during the rains also occurs in the lake at certain times of the year. It is known as *Pulla* all over Sind. The species was not common in the lake at the time of the Survey, but a specimen was seen with the fishermen at Shah Hasan.

Family Notopteridæ.

Notopterus notopterus (Pall.).

1769. *Gymnotus notopterus*, Pallas, *Spicil. Zool.*, VII, p. 40.
1889. *Notopterus kapirat*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 406, fig. 129.

Eight young and four grown-up specimens were taken from the lake. The largest individual is 280 mm. long.

Notopterus chitala (Ham. Buch.).

1822. *Mystus chitala*, Hamilton Buchanan, *Fish. Ganges*, pp. 236, 382.
1889. *Notopterus chitala*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 407.

The species is represented in the collection by a single specimen, 285 mm. long. This specimen has a number of pea-shaped dark spots on the caudal portion arranged in a single longitudinal row; a few spots are also present on the rest of the body.

Family Belonidæ.

Xenentodon[3] cancila (Ham. Buch.).

1822. *Esox cancila*, Hamilton Buchanan, *Fish. Ganges*, pp. 214, 380, pl. xxvii, fig. 70.
1889. *Belone cancila*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 420, fig. 136.

Three specimens of the species were collected from the lake; the largest of these is 200 mm. long.

Family Percidæ.

Ambassis ranga (Ham. Buch.).

1822. *Chanda ranga*, Hamilton Buchanan, *Fish. Ganges*, pp. 113, 371, pl. xvi, fig. 38.
1889. *Ambassis ranga*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 485.

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[1] Regan, C.T., *Ann. Mag. Nat. Hist.*, xix (8), p. 307 (1917).
[2] Regan, C.T., *Ann. Mag. Nat. Hist.*, xix (8), p. 306 (1917).
[3] Weber, M. & L. F. de Beaufort, *Fishes, Indo-Austral. Archipel.*, iv, p. 134 (1922).

A large series of young and middle-sized specimens was obtained from the lake.

Ambassis baculis (Ham. Buch.).

1822. *Chanda baculis*, Hamilton Buchanan, *Fish., Ganges*, pp. 112, 371.
1889. *Ambassis baculis*, Day, *Faun. Brit. Ind., Fish.*, I, p. 485.
Only young individuals of this species were collected from the lake.

Family GOBIIDÆ.

Glossogobius[1] **giuris** (Ham. Buch.).

1822. *Gobius giuris*, Hamilton Buchanan, *Fish. Ganges*, pp. 51, 360, pl. xxxiii, fig. 15.
1889. *Gobius giuris*, Day, *Faun. Brit. Ind., Fish.*, II, p. 266.
The species is represented in the collection by many young and middle-sized specimens, the largest of which is 110 mm. long.

Family MASTACEMBELIDÆ.

Mastacembelus pancalus (Ham. Buch.).

1822. *Macrognathus pancalus*, Hamilton Buchanan, *Fish. Ganges*, pp. 30, 364, pl. xxii, fig. 7.
1889. *Mastacembelus pancalus*, Day, *Faun. Brit. Ind., Fish.*, II, p. 333.
Seven young individuals of the species were collected from the lake. They vary from 50–60 mm. in length.

Mastacembelus armatus (Lacép.).

1822. *Macrognathus armatus*, Lacépede, *Hist. Nat. Poisson*, II, p. 286.
1889. *Mastacembelus armatus*, Day, *Faun. Brit. Ind., Fish.*, II, p. 334.
There are six adult and one young specimen in the collection. The largest adult is 560 mm. long. The colouration, which is very bright in young individuals, becomes duller with age.

Family OPHICEPHALIDÆ.

Ophicephalus striatus Bloch.

1793. *Ophicephalus striatus*, Bloch, *Nat. Ausl. Fische*, VII, p. 141,
1889. *Ophiocephalus striatus*, Day, *Faun. Brit. Ind., Fish.*, II. p. 363.
Two specimens of the species, about 165 mm. long, were collected from the lake. *O. striatus* appears to be less common than *O. punctatus* in the Manchar Lake.

Ophicephalus punctatus Bloch.

1793. *Ophicephalus punctatus*, Bloch, *Nat. Ausl. Fische*, VII, p. 139.
1889. *Ophiocephalus punctatus*, Day, *Faun. Brit. Ind., Fish.*, II, p. 364.
A large series of specimens of different sizes was collected from the lake; the largest individual is 155 mm. long.

Family ANABANTIDÆ.

Trichogaster lalius (Ham. Buch.).

1822. *Trichopodus lalius*, Hamilton Buchanan, *Fish. Ganges*, pp. 120, 372.
1889. *Trichogaster lalius*, Day, *Faun. Brit. Ind., Fish.*, II, p. 373.
This species is very common in the Manchar Lake and a large series of specimens of different sizes was collected. The dorsal and the anal fins are pointed posteriorly in most specimens, but in some they are more or less rounded. In *T. lalius* the lateral line is very variable. Besides the specimens from the lake, we have examined large series of specimens from different localities preserved in the collection of the Zoological Survey of India, and find that the lateral line in this species may either pierce 4–6 anterior scales, or be vestigial; in some specimens, however, it is entirely absent. In *T. fasciatus* the lateral line is complete or interrupted about the middle of the body.

[1] McCulloch, R., and Ogilby, D., *Rec. Austral. Mus.*, XII, p. 235 (1919).

WOLVES IN SHEEP'S CLOTHING

(*ACANTHASPIS* AND *CHRYSOPA*)

(*With seven illustrations*)

BY

MAJOR R. W. G. HINGSTON

Here we investigate a problem in protection. Certain creatures prowl about like wolves in sheep's clothing. Outwardly they look perfectly harmless. They have put on a dress of innocence that hides the ravenous nature underneath.

Disguises, of course, are widespread in Nature. A host of insects assume the appearance of something altogether different from themselves. Instances innumerable could be given. Certain beetles simulate dangerous wasps; the enemy imagines they are armed with a sting. Certain flies are dressed like humble-bees; it enables them to pillage the humble-bees' nest. Certain spiders are coloured and shaped like ants; it gives them a chance to grab their prey. Certain mantids are made to resemble flowers; the unsuspecting victim walks into their claws. And so on. There are many examples. This principle of unconscious simulation is real and widespread in the entomological world. But what are all these types of disguises? They are anatomical, part of the natural structure of the insect. The creature has been formed in this special way in order to secure some particular end.

In this paper I deal with a different class, not with creatures whose disguise is part of their anatomy, but with ones which employ extraneous materials as a kind of protective shield. They fall into two divisions; those which belong to the Rhynchota, and those which belong to the Neuroptera.

EXAMPLES FROM RHYNCHOTA

A place well worth entomological investigation is the foot of a tropical tree. There the student of minute things, though not necessarily little ones, will come across much of interest and delight. If he watches with particular care, he is likely to meet with an *Acanthaspis* bug moving slowly on the mottled coloured bark. Then again he may find one in a crumbling hollow or on the ground under fallen leaves. I have usually found them in the wet season when the foliage drips with moisture and pools collect in the hollow trunks. When noticed, they are worth some close attention, for they illustrate the wolves-in-sheep's clothing principle in a number of different ways.

OBSERVATION I.

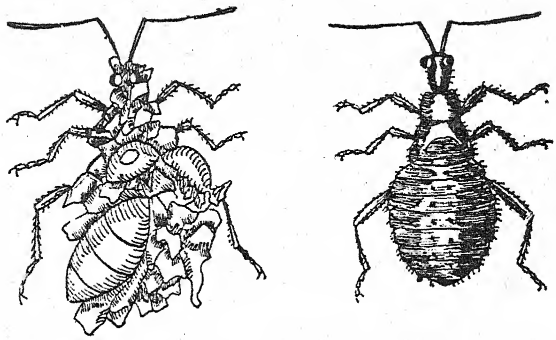


FIG. 1. (*a*) *Acanthaspis* disguised in insect fragments (*b*) *Acanthaspis* divested of disguise.

The first I observed was on the trunk of a Peepul. It was quite small, obviously immature, only one quarter of an inch in length. What did it look like? Just like nothing at all. Because its whole body was covered with a remarkably efficient disguise. In fact all one saw was a heap of rubbish. The insect's shape was completely concealed.

Let us first examine the heap. It was made up of a quantity of fragments. There was the abdomen of one ant, the head and thorax of another kind, some yellow shreds of a dried-up spider, and some grey particles of organic waste. All were heaped into a shapeless pile with the insect hidden underneath it. What a strange assemblage of dessicated materials! What a way to hide oneself from view! The whole collection made a pile considerably larger than the insect itself. It removed completely all insect-like appearance. The lump was not a living form, but merely some nodular excrescence on the bark. Further, the scheme of coloration had a distinctly concealing effect. It may be that the inseet picked out its materials. More probably the blending came about by chance. But at all events the heap of fragments harmonized exactly with the mottled bark. The blending was not due to any special colour, but to the intermingling of different shades which assimilated with the variegation of the tree.

I tilted off the load of debris. The owner was exposed, a triangular shaped insect with a flattened abdomen and conical thorax that narrowed into a small head. The tilting up of the fragmentary heap disclosed the way it was fastened on. Some filaments of thread came into view. They connected the fragments with the creature's back. The insect seemed dissatisfied when its burden was removed. Very soon it made efforts to get hold of it, first thrusting its legs under the lump and finally hoisting it on to its back. The lump, being restored, stuck firmly in place, getting entangled in the viscid threads that seemed to be emitted from some small papillæ situated close to the insect's tail. The main load was in position, yet the creature was not satisfied. It searched about for any fragments that had fallen loose, hoisted them up in the same way, and piled

them in rear of the main mass. A few more threads anchored these, some connecting the fragments to the mass, others linking them to the insect's back. Thus the whole collection was bound with threads, the individual fragments to one another, and the whole burden to the body of its host.

Now for another point. How did the insect get its burden? Without doubt from the desiccated carcasses of victims which it had itself destroyed. For this creature is both rapacious and carnivorous. Its beak is a curved penetrating lance, hollow like a suctorial needle, an instrument for sucking fluid from its prey. It is strong enough to penetrate the human skin, and, when it does so, a stiffening follows, which shows that the needle is not only suctorial, but also that through it a discharge of poison has been shot underneath the skin. We can, therefore, construct the following drama. *Acanthaspis* grabs its victim, probably a spider or an ant. In goes the lance; there is a squirt of poison; almost immediately the prey is numbed. Then a sucking follows. The victim is eviscerated. Lastly comes the extraordinary act. *Acanthaspis* puts the empty carcass on its back.

This brings us to the purpose of the garment. I think it must serve a double purpose. First, it must help the creature's depredations. The garment is a cloak that conceals the attacker and allows it get within reach of its prey. Second, it must have a protective value. The bark of a tree swarms with enemies, birds, ants, spiders and others. Beneath its disguise *Acanthaspis* is concealed from them. All they see is the excrescence on the bark.

Observation 2.

I captured another of these bugs in a hollow tree. The hollow was lined with woody debris, reddish bits of crumbling dust.

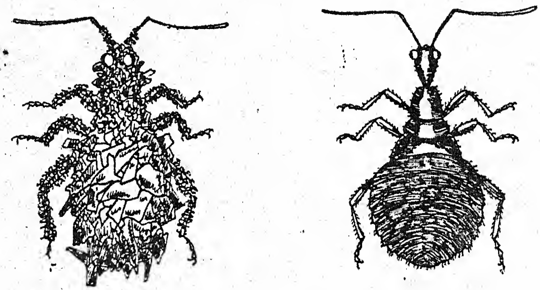


Fig. 2. (*a*) *Acanthaspis* disguised in fragments of wood. (*b*) *Acanthaspis* divested of disguise.

The *Acanthaspis* of this hollow was perfectly disguised. It had not gone in for a cloak of carcasses, but had clothed itself completely in particles of wood and a quantity of powdery dust. It had heaped the biggest bits on to its back, the smaller ones on its thorax and along its legs, the finest dust over its head, even fixing a few granules to the roots of its antennæ, and making the whole so complete a

garment that it altered entirely its appearance and shape. Its under surface was clear of debris. Obviously nothing was needed there.

What did it look like? Just a granulated nodule with fluffy legs, a mere lump of woody debris stuck in the crumbling hole. Only when the heap of fragments moved did one suspect the presence of life. No kind of artificial concealment could have been more perfect and exact.

OBSERVATION 3.

This one was found on the trunk of a *dhak* tree. It moved about freely on the bark, yet could be detected only with difficulty. It had clothed itself with bits of bark and leaves, the larger pieces on its abdomen and thorax, the smallest fragments on its antennæ and legs. Again the disguise was absolutely perfect, for the bark of the *dhak* tree is a network of fissures which give it a kind of nodular surface. The result was that the bug with its load of fragments looked as if it were one of these nodules on the bark.

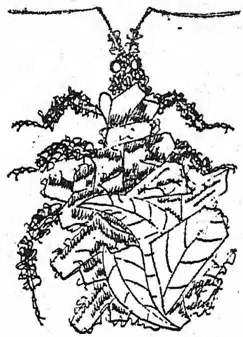


FIG. 3. (*a*) *Acanthaspis* disguised in bark and leaves.

OBSERVATION 4.

Here is another example. The bug was on open bark, and, as usual, hidden in its shield. But, in addition to the woody fragments, it had fixed a pointed thorn to the top of the fragmentary load. The thorn was fully as large as itself and gave it a still more unnatural shape. How had it happened? Probably the creature could not get enough fragments, and when searching for them, found the thorn which it then anchored firmly on top. Again see how efficient it was. Most of the trees in the neighbourhood were thorny. The bug, therefore, became a mere thorn like the ordinary thorns sticking from the bark. I pulled off its thorn. *Acanthaspis* pulled it back. Clearly it valued this spiny armour, and would have it on the top of its load.

FIG. 3. (*b*) *Acanthaspis* carrying a thorn

OBSERVATION 5.

I met another beneath a fig tree in the carpet of fallen foliage that lies profusely on the ground. To the insect this debris is a dense jungle, a world teeming with minute life. What had this creature of the jungle done? It had covered its whole body with earth, both its upper and under surfaces. Its head, its legs, even its antennæ were hidden completely in dust. It reminded one of a naked Hindu

priest who smears himself all over with ashes and earth. Again we have another exact concealment, a cloak of dust in dusty haunts. On the leaves it might have been conspicuous enough, but it stuck to the greyish soil, just a lump of dust surrounded by dust.

Observation 6.

My last example was under a stone. I found it on the granite rocks which cover so much area in Central India. Again its materials were perfect for concealment. On its back was a pile of granite crystals, and along its legs some sandy girt. Under such a hillock it was perfectly concealed, just a bit of rock living underneath and surrounded by rock.

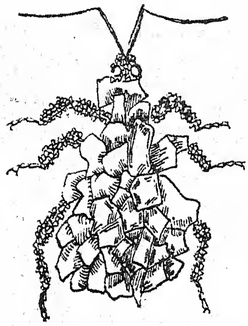


FIG. 3. (*c*) *Acanthaspis* disguised in granite crystals

Thus we see that these creatures are efficiently protected in accordance with the nature of their haunts. The coat may be made of all kinds of things, of animal remains, of decomposing wood, of rugged nodules, of projecting thorns, of earth, of dust, of stones. The environment varies, so does the investment. Surely a simple, yet wonderful defence.

Is this disguise of vital importance? Could the creature survive in its absence? I doubt it. Remember how acute is the struggle for life, and what a host of insectivorous creatures inhabit the bark of trees. A tropical tree-trunk, where these bugs mainly live, is a world of competing life. Nature's struggle is nowhere more insistent and anything may turn the scale.

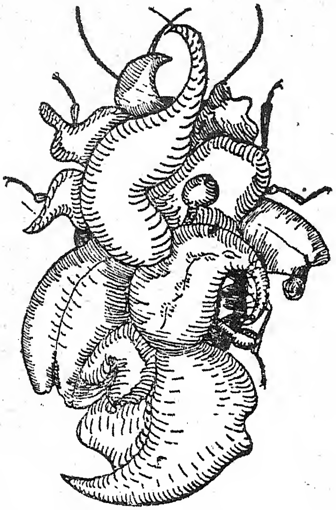
Examples from Neuroptera

I pass now to illustrations from another group. The device is similar; the insect is quite different; also the contrivance for fixing the burden is of an altogether different kind.

Observation 1.

One evening in March, when the mango was in bloom, I was watching the habits of the Red Ants. Many of them searched the inflorescences where they eagerly sipped up sap. The mango inflorescence was an excellent hunting ground. All kinds of creatures visited it repeatedly. But what do I see in one of these inflorescences? A slight agitation, a small movement, as though a bit of mango flower was slowly wandering about. It was only a heap of half-dried petals; nevertheless it changed its place and crept along the stem. What was it? Another of these artificial disguises. Underneath the heap was a fragile creature. The cluster of petals was only a cloak.

I removed the garment. A delicate creature came into view. It was a Chrysopa larva, a minute insect belonging to the order of Lace-Wing Flies. It was quite insignificant, completely defenceless, only three-sixteenths of an inch long. Of spindle shape, its flat



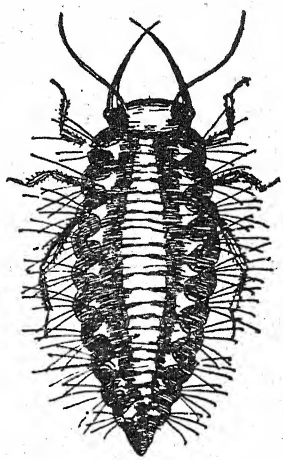


FIG. 4. (*a*) *Chrysopa* disguised in mango petals. (*b*) *Chrysopa* divested of disguise.

body was broad in the middle and graduated to both ends. Its head was square. Long slender jaws jutted out in front. Its hind end was more acute and tapered to a flexible tail. This tail was an important organ of progression. The larva used it as a seventh leg to propel itself from place to place. But the special thing to notice were the long hairs that projected from both sides of its back. They rose in tufts from elevated nipples. Each segment had two tufts. Combined, the tufts made two rows, one down either side. They were absent from the middle of the back which was perfectly smooth. What were these hairs for? Few could guess their peculiar purpose. We will learn it by examining the creature with its load.

Its back is completely covered with petals: they conceal it from head to tail. Only the leg tips on each side and the points of the jaws in front stick out beyond the flowery heap. I put it with some petals in a glass tube. Its concealment was complete. Not the slightest trace of it could be detected until it began to move. I removed its petals. It seemed discomfited. Like the *Acanthaspis*, it wanted to get them back. I then put it on an inflorescence. It crept through the bloom, searching for petals, climbing across from flower to flower. Then it began replacing the heap. It continually took petals in its jaws. Some were fixed and could not be shifted; others were too large to fit into the cloak. These ones were rejected after examinaion. But here and there it found a suitable bit. Up went the fragment on to its back. The hoisting method differed from that of the bugs. They use their legs as a kind of derrick and hoist up the materials from behind. The larva gets them between its jaws and tilts them on to its back. The act is done by bending the neck. Only a very flexible creature could do it. Chrysopa can

manage it through its great flexibility and its particularly long jaws. Its jaws, in fact, can transfer the petals right back to the point of its tail. In this way petal after petal is pushed backward, and Chrysopa rapidly gets covered up.

Now for the purpose of the hairy tufts. I noticed that the larva, when making its cloak, put the petals on the middle of its back between the lines of tufts. The hairs of the tufts then caught the petals. They were the anchors that held the cloak. It was perfectly obvious how they held it on each side. Being, long and stiff and arranged in lines, they made a wall on each side of the load. But also I feel sure they had a gripping function. Their tips were slightly curved, and I imagine that, under the stimulus of the petals, they even bend a little more. It is difficult to be certain, but I suspect that these hairs are delicately sensitive, have the power to curl on themselves and actually clutch the load. Here then we have a highly specialized machinery. The fragments are gripped very efficiently. A shake will not shift them, nor will the movements of the larva. The petals are fixed tight. The contrivance is quite different from that of *Acanthaspis*. The bug has a spinning-wheel which shoots out threads; the lace-wing has two lines of grappling-irons which literally seize the load.

We note how two creatures so different in structure gain concealment by the same plan. How did they come by it? Perhaps, one may say, from a common ancestor. Some creature in the past learnt the trick and handed it down to both lace-wings and bugs. That is the explanation usually given to these similarities. Similar structures or similar instincts, and we postulate a common source. But here the explanation is inadmissible. Lace-wings and bugs are too distantly related. They are as different as a dragon-fly from a cicada. They could never have derived the habit from a common ancestral stock. Moreover their methods of hoisting are quite different which would not be the case had they come from the same source. A common origin is out of the question. What has happened is that bugs and lace-wings have hit on the same device independently. It is an instance of convergent evolution. Each has made the discovery for itself.

Again we ask what is the reason? Does the disguise benefit Chrysopa in the same way that it did *Acanthaspis?* Undoubtedly. A glance shows us that Chrysopa is rapacious. What other purpose for its long curved jaws. Its business in the flower is to catch insects. I gave it some fragments of a small insect. In went its jaws to suck out the juice. Obviously it captures only small species, mainly, I think, Aphids and Coccids which live on flowers and stems. Its disguise must assist it to approach these creatures. To them Chrysopa is only a flower. But the shield must also have protective significance. A mango inflorescence, like the bark of a tree, is a busy active world. A myriad of insects inhabit its bloom. Bugs of many kinds, predacious ants, visiting hymenoptera, parasitic diptera, many varieties of hunting-spiders perpetually hunt it for food. Some come to get the nectar; others to catch prey. Chrysopa has to live through all this competition. Enemies surround it. It has no weapons. Its movements are so slow that it could never escape.

What then does it do? Becomes part of the flower by heaping petals on to its back.

OBSERVATION 2.

Here is another example that I met with, this one on the stems and leaves of the mango. It had not gone in for a floral covering. Its disguise consisted of a white skin. The garment is interesting. Obviously a coat of white skins could not shield an insect on a yellow flower. There was nothing of a harmonizing character about it. The skin was conspicuously, even glaringly, white. But it soon became clear that the wearers of the skins were not in the habit of haunting the inflorescences. They lived on the stems and leaves. There they looked like white flakes quite conspicuous against the green.

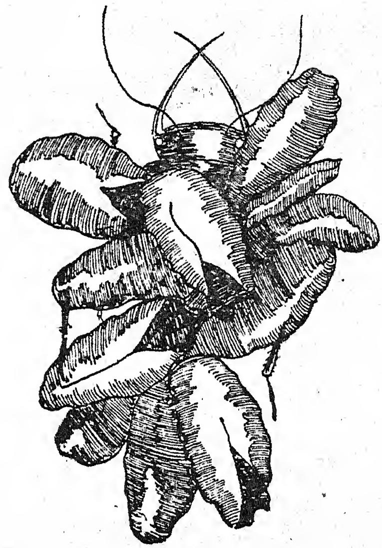


FIG. 5. (*a*) Chrysopa disguised in skins of *Monophlebus*.

How can Chrysopa be protected on a leaf by looking like a white skin? The explanation is simple. That conspicuous Coccid, *Monophlebus stebbingi*, is very common on mango leaves and stems. The females look like white lumps that collect in clusters around the stalks. There they develop, cast their skins, which remain like snow-flakes sticking to the tree. The cast skins, of course, are perfectly worthless, yet Chrysopa gets hold of them, hoists them on its back and fixes them with its grappling-hooks. It is the abundance of these skins which gives protection. Sometimes the leaves almost look as if snowed on. What then does the larva become? Why, merely a snow-flake surrounded by snow. A garment of flowers would be useless on foliage. Chrysopa behaves as if it knew this. It puts on what it finds on the leaves. Most that I met with had one or two skins. But one had collected a regular heap of them. On its back was a mountain of skins, one piled on top of the other, and many times the larva's size.

OBSERVATION 3.

I come to a third illustration. This one lived on the soil underneath a tree. The place was infested with many ants. I suspect that Chrysopa killed them in numbers. At any rate on its back was a pile of their carcasses. It had made a disguise out of their remains. How like the *Acanthaspis* inhabiting the bark which had manufactured a similar cloak. Let us look at it in detail. There was one large black abdomen, two pale yellow heads, the

complete carcass of a small red ant, and a quantity of indefinable debris, all collected into one heap. The disguise was motely in materials and colour. Its non-descript appearance made it suited to its haunts. It was a bit of insect debris lying on the insect haunted ground.

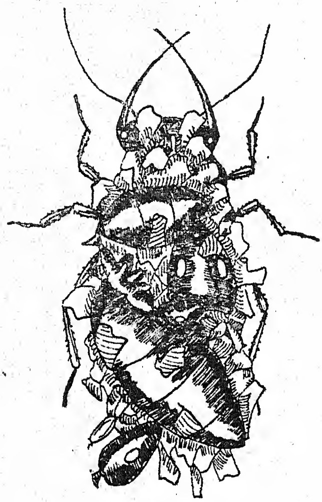


FIG. 5. (*b*) Chrysopa disguised in insect fragments.

An incident in respect of this example showed how strong is the creature's instinct to pile materials on to its back. I happened to put it with its load into spirit. When I thought it must be dead I took it out. But it soon revived. And what was its first act? To heap on its back the fragments of ants that had happened to get separated from its load!

OBSERVATION 4.

I saw some red ants carrying another one. They were pulling it away to their nest. On its back was a slender thorn, the base of the thorn being fixed to the hairs, and the point directed away from its back. This again was a device employed by *Acanthaspis*. It shows how similar objects are chosen by creatures of widely different types.

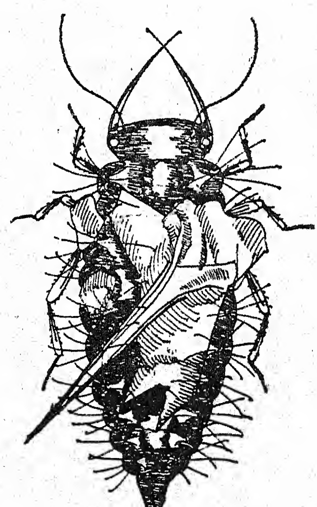


FIG. 5. (*c*) Chrysopa carrying a thorn.

OBSERVATION 5.

I met with still another example. It must have belonged to a different species, for its anchoring machinery was differently devised.

I found it on the bark of a fig tree. Its disguise, as in the last mentioned illustration, was composed of a heterogeneous mixture of ants. They covered its back in a nodulated heap, which overhung its body all round. Numerous fragments went to make the heap. There were the complete heads of two brown ants, three yellow abdomens, a quantity of fragments in which could be distinguished some dried up legs and jaws. The whole assemblage was held together without difficulty, and the tent of carcasses moved about whenever its occupant stirred.

The larva was seated near a file of ants. I saw it try to capture

one of them. No doubt they form its habitual food. Hence the value of the cloak is clear. When an animal stalks a victim, can it have a better disguise than to hide itself in its victim's skin?

But the special point of interest in this example lay in the method by which the load was attached. I noticed that the heap was very firmly secured. A more than usual effort was needed in order to pull away the bits. One would think that the hairs had some sticky stuff on them, so firmly did they cling to the load. To the naked eye there was nothing peculiar. All one saw was the usual system of nipples, a line along either side, each supporting a tuft of hairs. One noticed, however, that the hairs were longer; also there were many more of them, and that when a hair was touched with a needle it was inclined to stick to the steel. The microscope, however, disclosed the reason. On high magnification it could be detected that these were not ordinary simple hairs of the type which were present in the previous illustrations. This Chrysopa had specialized hairs. Each was something like a delicate saw. It was furnished throughout its length with teeth, the opposite sides being similarly armed. (See fig. 6). This fact tells us why the fragments are secure.

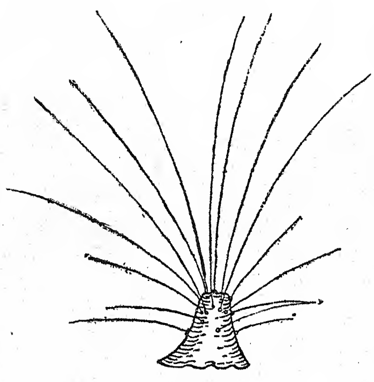


FIG. 6. Hair tuft of Chrysopa larva.

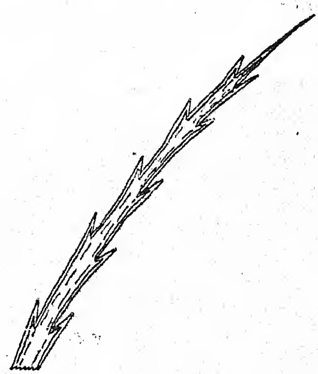


FIG 7 Extremity of hair highly magnified.

This larva has a special kind of gripping apparatus, a double row of microscopic saws. Hairs, we have seen, can grip of themselves; they can easily hold a heap of petals. But this species seems to require something better. It needs a set of gripping teeth. We ask ourselves.—Why? I expect it is because of the nature of its load. Crumpled petals are light as air. Their surface is rough and outline irregular. They can be kept down by the touch of a hair. But this species lives habitually on ants. The fragments of ants have smooth surfaces; their heads and abdomens are polished and slippery. Simple hairs will not grip them properly; something additional is required. Nature steps in and supplies the addition. Teeth are placed along the hairs, which grip and secure in the tightest manner the smoothest fragments of the cadaverous pile (Fig. 7).

How wonderful it all is! Nobody notices these insignificant creatures. They possess no practical utility; hence they are almost beneath contempt. Admittedly they are very minute. The combination of insect and shield is not the size of an ordinary pea. Moreover their lives are strictly obscure. They haunt the nooks and crannies of the world and must be sought for in order to be seen. But surely their habits are highly remarkable, and none the less so because they are minute. We so often look to what is large and striking and forget that a thing is no less wonderful because it merely happens to be small. What would it be if these creatures were big? Were a lion discovered that stalked its prey, then heaped the dried up carcasses on its back in order to make a stalking disguise. Were it found in addition that the beast possessed a machinery of saws for the purpose of fixing these carcasses, then surely the animal would be regarded as one of the greatest wonders of creation. All the world would flock to see it carrying its burden of zebras and gazelles. Perhaps the comparison may seem too fanciful, yet Chrysopa presents an identical picture on a very reduced scale. Forget that Chrysopa is pinhead in size; forget that it is rare and seldom seen; then it becomes the imaginary lion and our wonder should be exactly the same.

We have seen the variety of materials used in making these shields. *Acanthaspis* uses ants, wood-dust, bark, a convenient thorn, a coat of earth. Chrysopa puts on petals, skins or thorns. Do they select these particular materials? Can they think out what is best for their protection, and then choose in accordance with their thoughts? Let us see. I deprive Chrysopa of its coat of skins and put it on some bits of leaves. What happens? It hoists the leaves on to its back and uses them instead of the skins. I put it on earth, then amongst petals, then on a layer of wool. The same thing happens. It hoists on its back whatever it meets with. The earth, the petals, the wool are used indiscriminately to make a shield. Thus the larva uses whatever is available, if suitable in size and weight. Can we then say that it chooses its materials? Only if we may regard as choice the capacity to make the simplest discriminations. It can separate the big from the small, the heavy from the light. But this is about all. It does not choose the character of its materials. Earth, wool, petals; each will satisfy it equally well. Its instinct is to use whatever lies near to it. The instinct, though so simple, yet is highly efficient; for the things that lie near it are the bits of its environment, hence it clothes itself instinctively in things best fitted to blend with its haunts.

These creatures survive by reason of their clothing. Let us look for a moment to the struggle they endure. Take that favoured haunt, the bark of a tree, particularly some old and crumbling trunk on which a varied fauna lives. We can scarcely exaggerate the endless intricacies that exist in this battle of the bark. Two armies live in ceaseless competition, the army of destroyers and the army of destroyed. First for the destroyers. Who are they? They consist of columns of carnivorous ants that seize on every creature they meet with, of rapacious spiders that pounce on their victims or ensnare them in hollows and clefts, of predacious bugs, raptorial

beetles, a mantis that waits with scissor-like legs, a scorpion that lurks in a narrow fissure with its claws sticking out from the chink. Add to these the crowd of occasional visitors: insectivorous birds, plundering reptiles, predacious hymenoptera, parasitic diptera, and some idea will be gained of the host of destroyers that invade the bark. Turn now to the crowd undergoing destruction. There are night-haunting moths that come to it for shelter, wood-boring beetles that eat their way into it, fish-insects in its crannies, diptera in its hollows, coccids climbing up to its leaves. Then there is a myriad which seeks safety by the device of harmonization. There are Jassids and Cicadas that blend with its surface, Membracids that look like projecting thorns, butterflies like decaying leaves. There are caterpillars the image of withered sticks and their pupae that look like mere nodules of bark. A raptorial host is waging destruction; another host is struggling to escape. So it goes on, battle within battle. One lot is searching; another lot hiding. Never for an instant does the contest cease.

In the midst of this battle live these wolves in sheep's clothing. They cannot keep in holes and fissures, but must come into the open and search for food. Yet like their competitors they must have protection. Hence the artificial disguise.

ANTS AND THE LAC INSECT (*LACCIFER LACCA*)

BY

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(*With three plates*)

Introduction

There is a strongly held idea that ants in general and some of them in particular are very injurious to the lac insect and during the last three years there have been complaints from cultivators, that ants have been doing a great deal of mischief to their lac crops. Stebbing as early as 1910 quotes authoritative letters of Joshi, a forest ranger, and Stevens, an I. F. S. Officer in charge of Kumaon Division, about the havoc done by *Camponotus compressus* to the lac insects. Lefroy and Misra did not consider ants injurious, though the latter in his Bulletin No. 185 has hinted at the probable injury done by the ants to the lac insect. Hautefeuille, who apparently did not attach much weight to the information received from Indo-Chinese cultivators that there are species of ants which devour the stick lac, considered perhaps on the balance of evidence that there are species of ants which interfere with the formation of lac. According to the informants of Hautefeuille, the small black species of ants are harmful and the large pale red species of ants useful. Imms and Chatterjee considered ants useful rather than harmful. De Flacourt also mentions of the ravages of ants in Indo-China, but does not give the specific names of either useful or harmful species.

Camponotus compressus, Fabr. (Pl. I, figs. 1, 1a, 2, 2a).

General description.—Hingston has given an admirable account of this ant in his book *A Naturalist in Hindustan.*

The formicary generally lies at the base of a tree, at times in the open field. It has also been found living with the termites in their nest.

To the lac insect the ant is supposed to be the most injurious species, and is very common throughout India.

Ant and intruder.—On the approach of a person to a plant visited by the ant, the smaller worker minors drop down to the ground, probably to warn the soldiers of the approach of any enemy. But the big worker minors and the soldiers present keep moving excitedly round their 'cattle' (the insect which gives them honey). If the intruder touches the 'cattle' with a needle, the nearest soldier or worker minor of bigger size darts forward, catches the needle with its powerful jaws, and bites it angrily; other ants

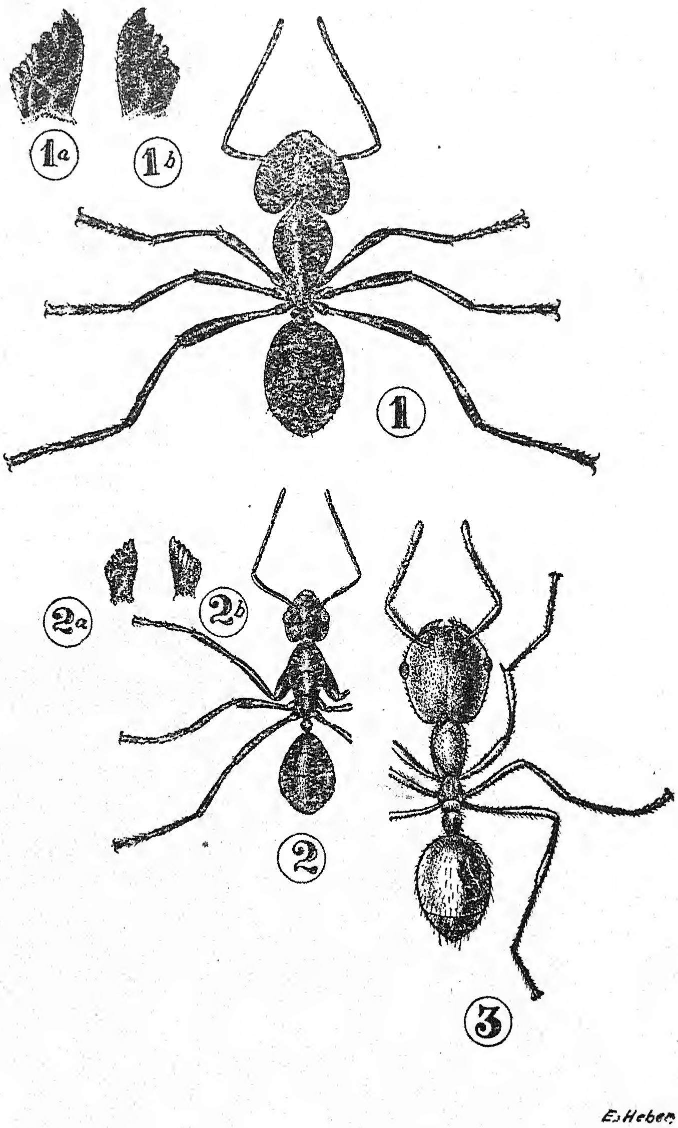


FIG. 1. *Camponotus compressus*, soldier. × 3.
FIG. 1a, 1b. Ventral and dorsal view of the mandible of the soldier. × 3.
FIG. 2. *Camponotus compressus*, worker minor. × 3.
FIG. 2a, 2b. Ventral and dorsal view of the mandible of the worker minor. × 3.
FIG. 3. *Solenopsis geminata*, worker minor. × 12.

in the neighbourhood follow to help it and try to reach parts of the body of the intruder. They fight tenaciously, unless one shakes them off with a jerk of the needle.

Behaviour towards lac insect and its enemies.—The ant *Camponotus compressus* has never been found meddling with the crawling larva of the lac insect; but it visits the lac insect from the time it has fixed itself on the plant for the 'honey-dew', which it exudes. The worker applies its mouth close to the anal orifice of the lac insect through which 'honey-dew' is excreted. If the lac insect does not emit the 'honey-dew' the ant strokes it with her antennae at the anal orifice and waits patiently. When the honey exudes the ant presses its jaws into the drop, grips it and runs away. But if the lac insect fails to respond to the coaxing of the ant, it bites at the encrustation round the anal tube and sometimes even thrusts its jaws into the anal orifice to find the 'honey-dew'. In neither case does it injure the insect nor the covering of resinous matter of its benefactor, although it might easily do so with its powerful jaws. If this threat fails to fetch the coveted drop of honey, it passes to the next insect. This in itself shows that the ant does not prey on the lac insect.

This was however further confirmed by pricking the lac insects, when it was found that the workers which come to visit the insects for 'honey-dew', on scenting the smell of the body juice ran away thereby showing that the smell of the body juice is repugnant to the ant. It has never been seen taking away even the injured insects.

On the other hand if a living or injured *Eublemma amabilis, Holcocera pulverea* or Chalcid larva be exposed, the worker on the look-out steps forward, catches the larva in its jaws and carries it off to the formicary. To avail itself of this booty, the ant even leaves the 'honey-dew' for which, at other times, it waits so patiently near its cattle.

The ant would prove still more useful to the lac insect if it would take out the larvae of these enemies of the lac insect from under the damaged incrustation. But unfortunately in, spite of its powerful jaws, it has never been found attempting to tear off the thin film of the damaged incrustation, which separates it from the coveted food.

Choice of cattle.—In plants infested both with the lac insect and membracids, the ant pays more attention to the membracid nymphs than to the lac insect, because it gets more honey from the latter than the former; this is especially the case in the young stages of the lac insect, when it excretes only a small amount of honey. At times the ant practically avoids the lac insect and attends the membracid continuously.

Beneficial to the lac insect.—The above ant is therefore useful to the lac insect in at least two ways:—

(1) It removes the excreted 'honey-dew', which, in the absence of ants and rains, would accumulate along with the dust on the encrustation and suffocate the insect by blocking its brachial pores.

(2) It picks up the *Eublemma* and *Holcocera* larvae while they are trying to enter the encrustation after hatching from the eggs,

and thereby reduces the number of lac enemies before they have actually done any injury.

Probable injury to the Lac insect.—The only apparent injury the ant does to the lac insect, is that while walking about on the lac encrustation, it breaks off the brachial waxy filaments, the profuse growth of which is the only sign of a healthy lac insect for a layman, and in so doing, it may block the brachial pores of the lac insect with the wax, but this appears to be rare because the brachial filaments are not very fragile, and in the insects, on the trees which are constantly visited by the ants, the brachial filaments seldom grow long, as the constant movements of the ants keep them short; moreover, the function of the wax in itself seems to save the brachial passages from being clogged up. However if some insects meet their death by this unconscious behaviour of the ants, the injury can only be called mechanical and unintentional.

The above information regarding the relations of *Camponotus compressus* to the lac insect, also applies to the ants discussed in the following pages, varying in degree.

Camponotus variegatus var. *fuscithorax,* Forel.

Worker (☿) major. Head, scape of antenna, thorax and abdomen dark fuscous brown; flagellum and legs yellowish brown. The colour of the thorax in the *Fauna* 'Yellowish brown', length in *Fauna* 8-10 mm.; our specimens 9·6-10 mm.

Worker (☿) minor. Netaceous brown all over, as in *Fauna,* but the apical portion of the abdominal segments slightly darker in colour, length 6-7·5 mm.

This ant also behaves to some extent like *Camponotus compressus* but the worker minor of this ant does not get so easily frightened as the smaller ones of *C. compressus* nor is the worker major so ferocious in battle as that of *C. compressus.* It is also a much less frequent visitor of the lac incest.

Camponotus sericeus, Fabr.

Worker (☿) major. Resembles in all details the description given in the *Fauna.* It is black opaque. Head very broad, opaque, massive, almost as broad at the base of the mandibles as at the posterior end of the head; mandibles have five teeth. Thorax broad in front, strongly compressed posteriorly. Metanotum (the last thoracic segment) forming an angle with the mesonotum (the middle thoracic segment), the basal portion of the metanotum horizontal, flat; apical portion excavate.

It is found visiting the lac insect along with *Camponotus compressus,* but is not very common.

Camponotus near *varians,* Roger. (Pl. II, figs. 4, 4a).

So far, we have not been able to find the males and females of this ant. It is met in large numbers in the winter months and especially in February and March.

It picks up the crawling lac larva, but does not meddle with the insect once it has fixed itself on the plant; and thereafter visits it only

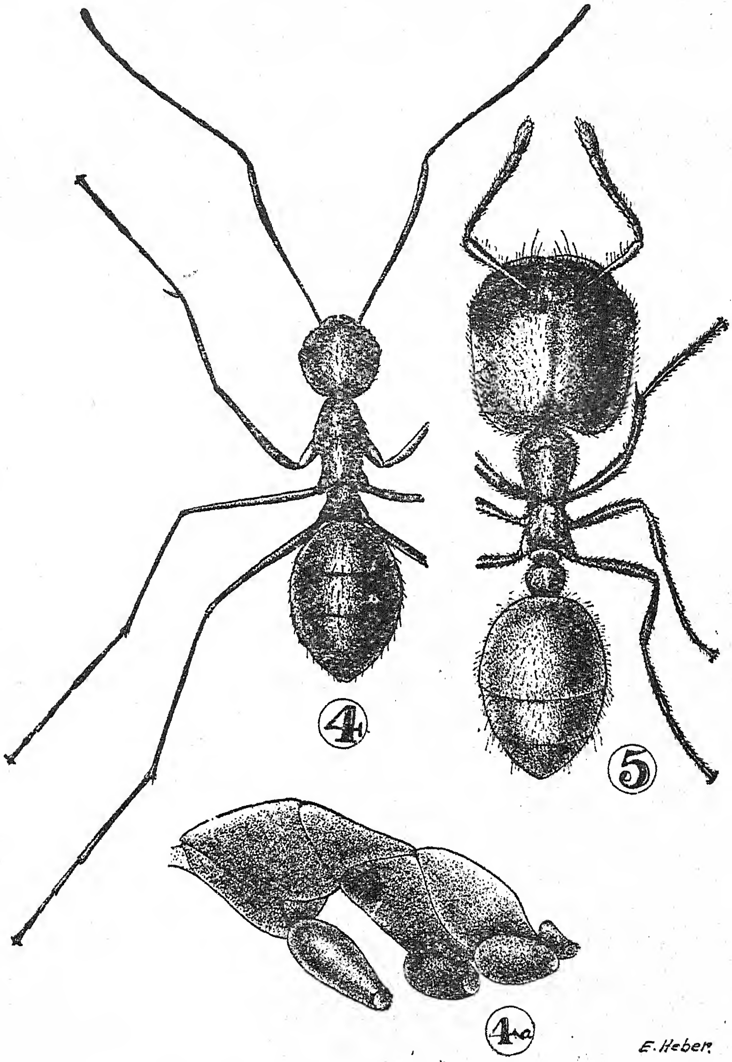
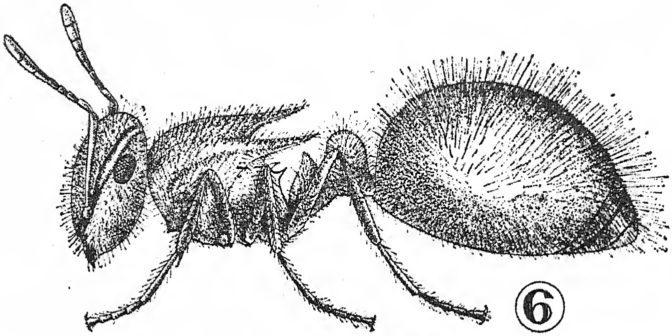


FIG. 4. *Camponotus* near *varians*, worker. × 20.
FIG. 4*a*. Lateral view of the thorax of *Camponotus* near *varians*, worker. × 60.
FIG. 5. *Solenopsis geminata*, soldier. × 12.



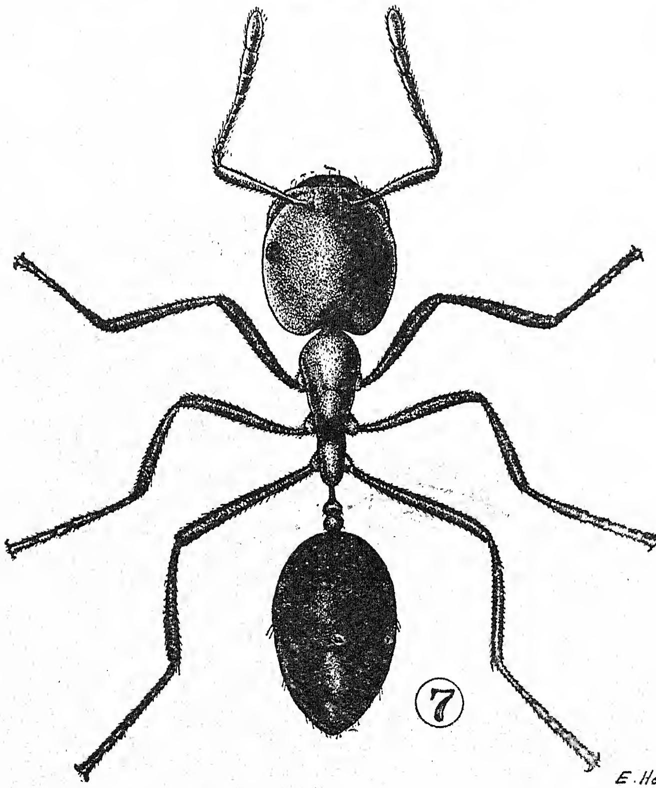


FIG. 6. *Meranoplus bicolor*, worker. × 20.
FIG. 7. *Monomorium* near *indicum*, worker × 20.

for the 'honey-dew'. It also picks up injured lac insects, but is incapable of breaking open the incrustation.

Meranoplus bicolor, Guér. (Pl. III, fig. 6).

The ant picks up crawling larvae and rarely visits plants over six feet high. It shows no abhorrence to the injured lac insect, sometimes even tastes the fluid of the lac insect, but afterwards shows signs of intoxication. It has not been noticed breaking open the incrustation.

Monomorium near *indicum,* Smith. (Pl. III, fig. 7)

So far the ant has been found visiting the lac insect during the summer only. It takes slight interest in the lac insect, and shows no signs of excitement at the approach of an intruder. It neither cares for the body juice of the lac insect nor shows repugnance to it; but abstains from taking away an injured insect, and it appears to visit the lac insect for the 'honey-dew' alone.

Solenopsis geminata, sub-sp. *rufa* Jerdon. (Pls. I, II, figs. 3, 5).

It bites virulently. Formicary under a tree or in the open field.

This ant is as prevalent as *C. compressus* at Namkum; and due to the large number of workers the trees visited by it are practically fully covered by the ant. It does not tolerate intruders and bites virulently. The ant picks up the lac insect larvæ, while the latter crawl about the branches to fix themselves, but once the insect has fixed itself, it does not meddle with it, otherwise it would be quite an easy task for it to remove the majority of the settled lac larvæ, before they could form a sufficient covering of resin to save themselves. However the ant has been observed to take away the intact male pupa, which it managed to reach by raising the opercular lid of the test; but it refuses to carry or does so, after great hesitation, if it be offered injured male or female cells. In the presence of sugar tubes on the plant, it neglects the lac insect altogether. This shows that it does not carry the living lac larvæ and the males in order to feed on them, but in the foolish hope that it could keep its 'cattle' safe in its nest and get the 'honey-dew' in exchange.

The ant kills exposed *Eublemma* and *Holcocera* larvæ in a few seconds and takes the booty to its nest. It also carries *Eublemma* and *Holcocera* larvæ from under the encrustation, if it finds a small opening available.

Iridiomyrmex anceps, Roger

Worker (☿) Head, thorax and abdomen dark castaneous brown, the first two and especially the latter with a black tinge; with a beautiful tinge of iridescence in certain lights; antennae and legs paler reddish brown, the latter with a slight tinge of black. Other characters as in the *Fauna.*

Length—in *Fauna* '3·5-4·5 mm.' Namkum specimens 4-4·3 mm.

The female. Black and granular; antennae dark castaneous brown; mesonotum raised and triangularly rounded posteriorly length 7·2-7·68 mm.

The male. Dark castaneous brown. Head small, ocelli forming an equilateral triangle on the vertex; thorax massive, mesonotum as in female, length 3·12 mm.

The ant picks up the lac larvæ and perhaps the male insects also, while they are crawling about. It shows signs of excitement at the approach of an intruder but has neither the strenth of *Camponotus compressus* nor the pluck and virulent biting power of *Solenopsis geminata*. It does not relish the body juice of the lac insect but appears to enjoy injured *Eublemma* or *Holcocera* larvæ. It very cautiously attacks the healthy uninjured *Eublemma* larva and takes *Holcocera* larva as the latter is very active.

Cataglyphis bicolor sub-sp. *setipes*, Forel.

This ant is very common at Namkum but never associated with lac. It has the formicary either near the path or in the broad field. Though the majority of workers are of large size '10-12 mm.' as given in the *Fauna*, yet one also comes across workers measuring about 7 mm. in length.

Ants associated with lac received from other districts.

1. *Camponotus compressus*, Fabr.	...	Denkanikota, Salem District, Madras.
2. *Camponotus mitis*, Smith	...	do.
3. *Camponotus nirvanæ*, Forel	...	do.
4. *Cataglyphis bicolor* sub-sp. *setipes*, Forel.	...	do. It is also found at Namkum but never associated with lac.
5. *Cremastogaster subnuda*, Mayr.	...	Barbala Estate, Assam.
6. *Cremastogaster dohrni* Mayr.	...	Denkanikota, Salem District, Madras.

The specimens of *C. dohrni* were collected at the time of the male emergence and some of the specimens had male insects in their jaws. This shows that this ant does pick up the lac larvae and the males.

7. *Sima* near *allaborans*, Walker	...	Salem District, Madras. Only two specimens of this were received.
8. *Solenopsis geminata Fabr.*	...	Mayurbhanj Estate, Behar.
9. *Tapinoma melanocephalum*, Mayr.	...	Denkanikota, Salem District, Madras.

Preventive measures.

As far as work has gone in this district, we consider measures against ants not only unnecessary but to a certain extent harmful. However, in places, where a species of ant predominates which

is suspected of being harmful to the lac insect, especially at the times of larval and male emergence, it can be successfully kept away from the lac insect, by either (1) pasting cheap molasses (*chhoha* or *seera*) round the bases of the stems of the host plants or sprinkling it on some long weeds and tying these round the base of the stems, or (2) by pasting bands of crude oil round the base of the stems.

The ants can also be distracted from the lac insect, if chewed or crushed sugarcane bits or honey combs from which all the honey has been extracted or any other sweet substance be strewn round the base of the stems of the host plants.

In Assam, according to Mrs. D. Norris, the Director of this Institute, a mixture, either of the gum or correctly speaking dried latex of *Ficus* sp. locally called *Barh* or of Sal (*Shorea robusta*) and mustard oil, in the ratio of one seer of gum to about half a chhatack of oil, prepared by heating over a fire for a few minutes and then applied round the base of the stem of the host plants, is employed with great advantage.

We tried the Assam method on a small experimental scale and found that the Sal (*Shorea robusta*) gum requires to soften it almost an equal quantity of oil, and even then, it is useless, as it becomes hard soon after taking out from the fire and is unable to catch the ants. The fresh latex of *Ficus bengalensis* (Bar), *Ficus religiosa* (Pipal), and *Ficus infectoria* (Putkal), each, requires about one-fourth its own quantity of oil to save it from drying and keep it fit to entangle ants, for a sufficient length of time. The dried latex of these require much larger quantities of mustard oil to bring the mixtures to a suitable consistency to catch ants. In Chota Nagpur the village boys use equal quantities of oil and latex of pipal to catch small red ant *Solenopsis geminata*, which bites virulently, out-witted trees and mustard oil, we found that about fifty workers of the small red ant *Solenopsis geminata*, which bites virulently, out-witted us by covering the one inch wide snare prepared for them with particles of earth in less than six hours. They thus prepared a good road to go to the lac insect; but our friend, *C. compressus*, the big black ant was not so wise and got entangled in the snare. Most of the species of ants of the sub-family *Myrmecinæ* will probably act like *S. geminata*.

From the above it appears that the expenditure required to meet the cost of the mustard oil which sells from about twelve annas to a rupee per seer and the cost of collecting the latex are not worth incurring, as the snare does not act for all the species of ants.

Acknowledgments

The authors wish to express their sincerest thanks to Lieut.-Col. R. B. Seymour Sewell, the Director of the Zoological Survey of India for the facilities given for the use of the Library of the Indian Museum, and to Mrs. Dorothy Norris, the Director of the Institute, for going through the manuscript, and to donors of specimens from different parts of India. We are also indebted to Messrs. C. F. C. Beeson and J. C. M. Gardner of the Forest Research Institute,

Dehra Dun for their valuable criticisms of the work now being published.

Summary

Eight more species of ants other than hitherto recorded associated with lac, are listed. A brief description of the relations of various species of ants to the lac insect is given.

Ants in general are not injurious to the lac insect, but some species undoubtedly pick up the crawling lac larvae and the male insects; at the same time all of them are useful to the lac insect as they remove the excreted 'honey-dew', which, otherwise mixed with dust in the absence of rains is likely to block up the respiratory organs of the lac insect, and cause its death by suffocation. In addition, many of them and especially *Camponotus compressus* and *S. geminata* help the lac insect by feeding on the larvae of the predator moths.

Use of cheap molasses is suggested to prevent the access of ants to the lac insect, in places where they are suspected of being harmful chiefly at the times of larval and male emergence.

Foreshore near Barkul in the Chilka Lake, Ganjam District, Madras Presidency, showing one of the typical algal formation, in which *Cladophora glomerata*, var. *Calicoma* is a predominant species.

**Reprinted from the Memoirs of the Indian Museum, Vol. V., Pl. I,* 1915, *with the kind permission of the late Dr. N. Annandale, F.R.S., formerly Director, Zoological Survey of India, Indian Museum.*

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE FRESH WATER ALGÆ OF MANIPUR, ASSAM.

BY

K. P. BISWAS, M.A.

(*Curator of the Herbarium, Royal Botanic Garden, Calcutta, September 2, 1929.*)

(*With 4 plates*).

In 1925, I received from Dr. S. L. Hora, Superintendent, Zoological Survey of India, a collection of Algæ in six tubes from the running water of streams and rivulets of Manipur. In the same year Mr. S. N. Bal, Curator, Industrial Section, Botanical Survey of India, added two more tubes to this collection, during his tour in Assam. Seven tubes out of the total number of eight tubes contained freshwater Algæ from the running water of streams and rivulets and a few from tanks and jhils of the Manipur valley. One of these contained sterile specimens of a Fungus.

The collections show that the hill-streams of Manipur, owing to their strong current, do not harbour many forms of Algæ. Only one species of each of the genera *Nostoc* and *Cylindrospermum* and two species of *Cladophora* growing on rocks, pebbles and stones formed the chief vegetation on the beds of the swiftly flowing hill-streams. A species of *Lyngbya* and a new variety of *Spirogyra setiformis* were found to grow in still water. The species of *Cylindrospermum* and one of *Spirogyra* were not in fruiting stage and hence could not be definitely identified. Except *Cladophora Crispata*, none of these five species mentioned in this paper appears to have been reported from India yet.

My best thanks are due to Prof. Paul Brühl for his valuable suggestions, during the preparation of this paper.

SYSTEMATIC ENUMERATION OF SPECIES.

CYANOPHYCEÆ.

Family.—OSCILLATORIACEÆ.

Genus.—LYNGBYA.

1. LYNGBYA MARTENSIANA, *Meneghini. De Toni, Syll. Alg. Myx., p. 279, 1907 ; Süsswasserflora Deutschlands, Österreichs u. d. Schweiz, Heft—12, p. 405, Fig. 521 a, 1925. Pl. iv, Figs. 12, 13.*

Filaments long, flexuous, 10–16 μ in width; sheaths colourless becoming thick and roughened with age, 1–3 μ in thickness; trichomes 8–10 μ in diameter, not constricted at the joints; apex of trichome not tapering, not capitate, apical cell broadly rounded; cells 2–4 μ in length; partition walls marked by protoplasmic granules; cell-contents granular, blue-green.

Hab.—In a jhil at Imphal, Manipur. Collected by S. N. Bal, October 20, 1925.

Geogr. Distribution.—Europe; Tropical Africa; Is. S. Halena; Central America; West Indies.

Family.—NOSTOCACEÆ.

Genus.—NOSTOC.

2. NOSTOC AMPLISSIMUM, *Setchell. De Toni, Syll. Alg. Myx., p. 421, 1907 ; Tilden, Minnesota Algæ, pp. 164, 180, Pl. viii, Figs. 17–19, 1910. Pl. i, Fig. 1.*

Plantmass forming lobulated, expanding irregularly, more or less verucose, brownish grey sack of mucilage adhering to rocks; filaments numerous, contorted, arranged irregularly; sheaths colourless; trichomes 2–3 μ in diameter, more or less torulose; cells D 2–4 μ in length, depressed spherical or sometimes somewhat oblong; heterocyst elliptic, 3–4 μ in diameter; gonidia ellipsoidal, single or in cantinate series, 3–4 μ in diameter, 5–6 μ in length, contents granular, wall of gonidum smooth.

Hab.—In a small stream by the hill-side, near Bishenpur, Manipur. Collected by S. L. Hora, March 1920.

Geogr. Distribution.—North America; California.

CHLOROPHYCEÆ.

Family—CLADOPHORACEÆ.

Genus—CLADOPHORA.

3. CLADOPHORA GLOMERATA, (*L.*) *Kuetzing; Forma*-RIVULARIS, *Rabenhorst. De Toni, Syll. Alg. Chlo., p. 295, 1889; Süsswasserflora Deutschlands, Österreichs u. d. Schweiz, Heft—7, p. 35, Figs. 14, 15, 39, 1921. Pl. iii, Figs. 3, 4, 5, 6, 7.*

Plantmass fasciculate, penicellate; cells of older branches 275–300 μ in length, 75–80 μ in width, cells of younger filaments 115–200 μ long and 25–35 μ broad, apical cells 135–350 μ long and 20–25 μ in diameter; intermediate or apical cells sometimes fructiferous; spores spherical or slightly oval, 10 μ in diameter, contents coarsely granular.

Hab.—In a swiftly running stream on rocks, Thoubaltural, Manipur. Collected by S. L. Hora, March 1920.

Geogr. Distribution.—Germany; Bohemia; United States; America; Ceylon.

4. CLADOPHORA CRISPATA (*Roth.*) *Kuetzing; var.* GENUINA (*Kuet.*) *Rabenhorst. De Toni, Syll. Alg. Chlo., p. 291, 1889; Süsswasserflora Deutschlands, Österreichs u. d. Schweiz, p. 41, 1921. Pl. iii, Figs. 8, 9, 10, 11.*

Plantmass cæspetose, filaments rather sparingly branched, subdichotomous, lateral branches short, sometimes unilateral; cells cylindrical, membrane thin, tenuous; diameter of the cells in older filaments varying from 40–70 μ, in younger 20–35 μ, about 5-10 times or more longer than broad; cell-contents disposed in a loosely spiral manner.

Hab.—In a rapidly flowing stream, Manipur. Collected by S. L. Hora, February 1920.

Geogr. Distribution.—Europe; North America; India; Burma.

The systematic position of the different species of the genus *Cladophora* has been discussed in detail by F. Brandt in his papers published during 1899 to 1909. Brandt's results have been excellently summarised by W. Hearing in *Süsswasserflora Deutschlands Österreichs und der Schweitz, Heft 7, pp. 3–62, 1921.* In this monograph the anomalous situation of the varieties and forms of the three well marked species, namely—*C. glomerata, C. crispata,* and *C. fracta*—has been made clear as far as possible, although, it becomes very difficult to distinguish them, especially when they are not found in natural condition. The short note in '*A Treatise on the British Fresh Water Algæ*' by G. S. West, revised and rewritten by F. E. Fritsch, pp. 169–170, 1927, is very useful for distinguishing these three main recognized species without much difficulty both in the field and the laboratory. F. Oltman's account in '*Morphologie und Biologie der Algen*', *Band i, pp. 347–356, 1922*, is very important for the study of this genus. The information given under *Cladophoraceæ*, in Band 3, *Chlorophyceæ* by H. Printz, in the revised edition of '*Naturlichen Pflanzenfamilien*', pp. 275–279, 1927, is an important contribution to our general knowledge of this family. The interesting results revealed in the paper entitled '*The Cytology of Cladophoraceæ*' by Nellie Carter, published in the *Annals of Botany*, vol. xxxiii, pp. 467–478, 1919, are valuable for those who wish to undertake further investigations in this line on Indian *Cladophoras*. The marine form of *C. glomerata*, var. *calicoma* has been described by the author in the '*Algal Flora of the Chilka Lake*' (now in the Press).[1]

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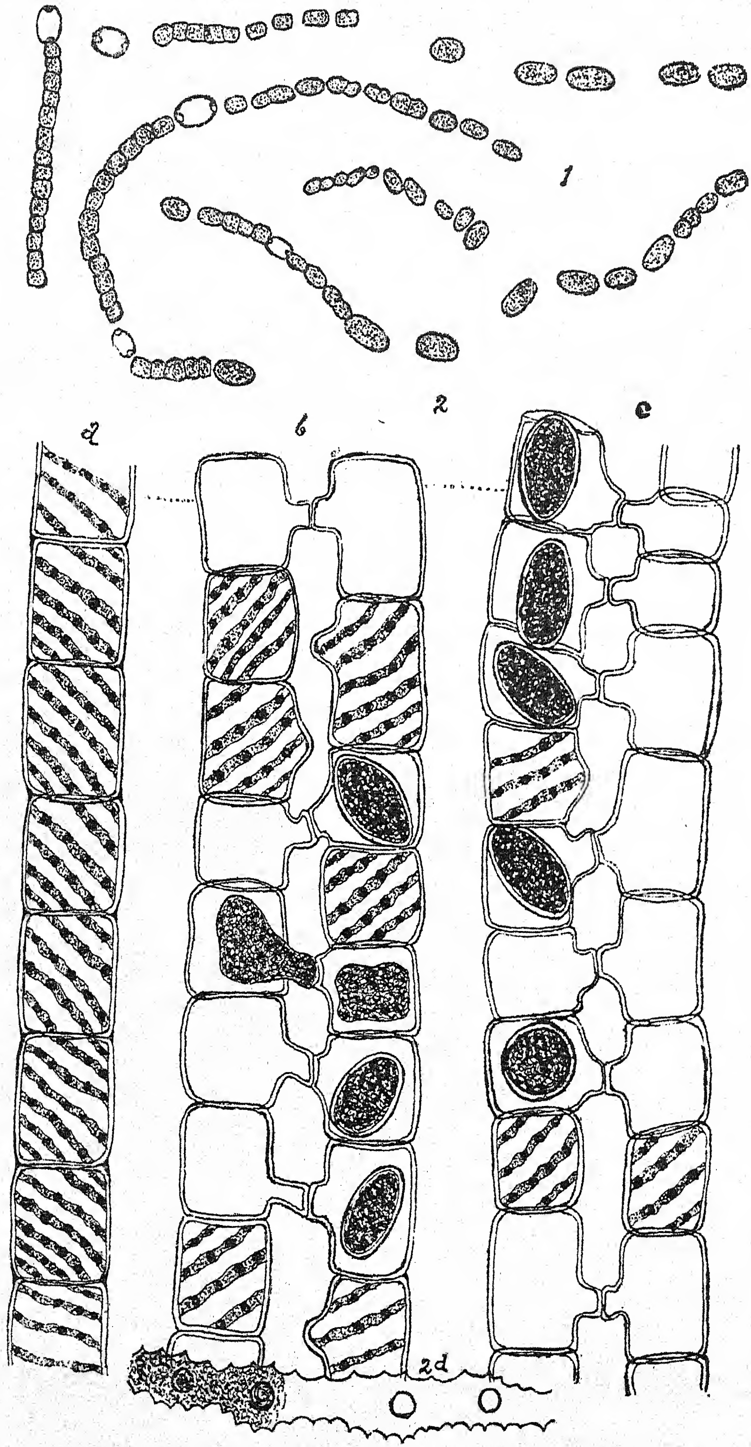
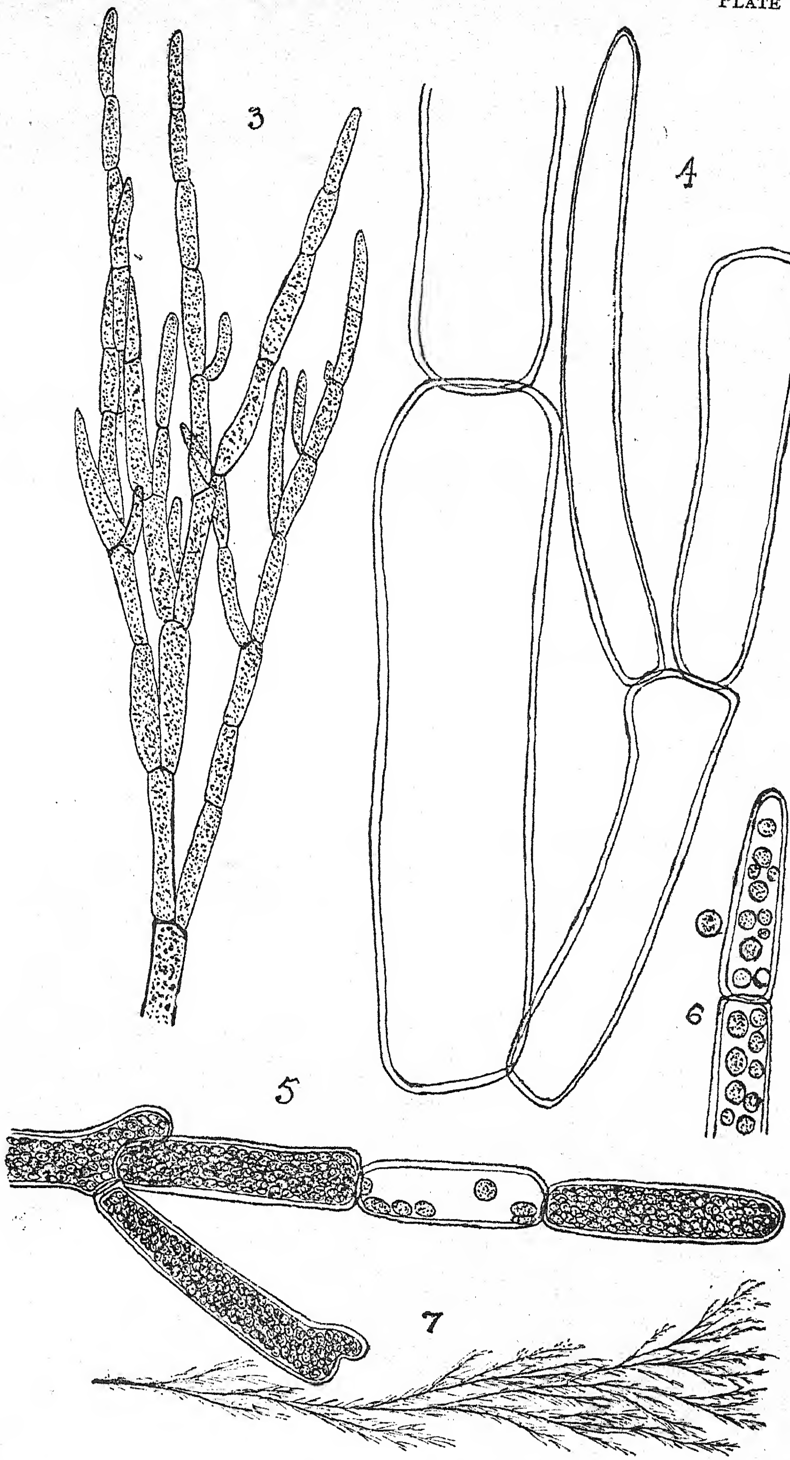
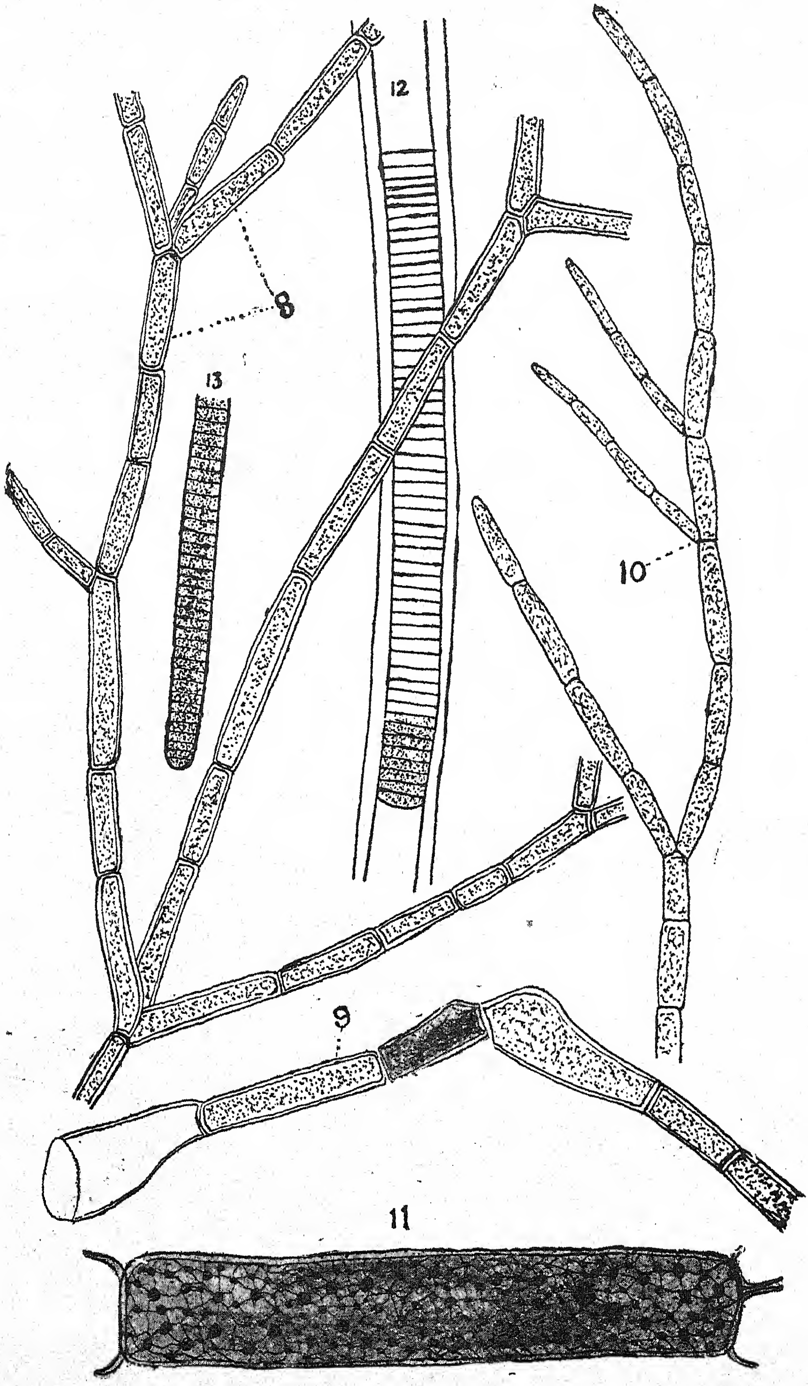
[1] Memoirs of the Asiatic Society of Bengal, 1930.



FRESH WATER ALGÆ OF MANIPUR, ASSAM.



FRESH WATER ALGÆ OF MANIPUR, ASSAM.



FRESH WATER ALGÆ OF MANIPUR, ASSAM.

For explanation see end of article. *K. Biswas, Del.*

This variety of *C. glomerata* grows profusely on stones and boulders along the rocky margin of the lake forming more or less a characteristic type of vegetation covering the areas sloping down into the water consisting of dried, half-dried and fresh plants, often mixed up with *Enteromorpha compressa*, *Gracilaria conferoides* and interwoven by *Lyngbya aesturii*. Plate I shows a portion of such a formation.

Family—ZYGNEMACEÆ.

Genus—SPIROGYRA.

5. SPIROGYRA SETIFORMIS (*Roth*) *Kuetzing*, *var.* MAIOR. *var. nov. Pl. ii Figs. 2 (a-d)*.

Cellulis vegetativis 135–175 μ latis, 165–225 μ longis, diametro subæqualibis vel duplo longioribus, fructiferis ad genicula non constrictis; membrana 6–8 μ crassa, distincta lamellosa; Chlorophoris 4-8, 10–12 μ latis, dentatis, densis, subverticalibus, anfractibus $\frac{1}{2}$-1; Zygotis prolato—ellipsoideis, Secus axin majorem visis globosis, 100–115 μ latis, 140–180 μ longis.

Hab.—In locis stagnalibus, Manipur. Lecta S. L. Hora, February to March, 1920.

Spirogyra setiformis and *Spirogyra jugalis* (*Dillw.*) *Kuetzing*, are closely allied species, and hence Cooke in his '*British Fresh Water Algæ*'—*p. 87, 1882-84*, suggests uniting both these species into one. Wolle too in his '*Fresh Water Algæ of the United States*', *p. 219, 1887*, although maintains their separate position after Mons Petit, is of opinion that these two species ought to be taken as one species. De Toni, however, considers them as two separate species and describes them accordingly in *Syll. Alg. Chlo.*, pp. 751–753, 1889. O. Borge in his contribution on *Zygnemaceæ*, in '*Süsswasserflora Deutschlands, Östterreichs und der Schwetz*,' *Heft 9, pp. 16 and 29, 1913*, has given more or less well defined characters for which these two species can be retained separate. *S. jugalis* differs from *S. setiformis* in the following two main characters: the constricted and longer forms of cells, often twice as long as broad and somewhat tumid shape of the fruiting cells. Moreover, *S. setiformis* is distinctly larger than *S. jugalis* in dimensions. Again, *S. setiformis* is related to *S. polytæneata*, Strasb., but the former differs from the latter in the smaller size of the cells and less number of Chlorophyll bands and their turns in each cell.

The new variety '*maior*' of *S. setiformis* is an intermediate form of *S. setiformis* and *S. polytæniata*. This variety is larger in dimensions than the typical form of *S. setiformis* but smaller than *S. polytaeneata*. The cells are 165 to 225 μ long and 125 to 175 μ broad. Cell wall is 6–8 μ thick. Chlorophyll bands are 4–8 in number, having $\frac{1}{2}$ to 1 turn in each cell (not 1-1$\frac{1}{3}$ turns in each cell as in S. polytaeniata) and more distinctly dentate, varying from 10–12 μ in width. Pyrenoids are 8 to 10 μ in diameter. Conjugating tubes vary from 40–50 μ in width. Zygote is a prolate ellipsoid, elliptic in front view but spherical in top view, and varies from 100-115 μ in diameter.

Hab.—In a tank in the residency at Imphal, Manipur. Collected by S. L. Hora, February to March, 1920.

EXPLANATION OF FIGURES.

PLATE II.

FIG. 1. *Nostoc amplissimum*, x800.
FIG. 2. *Spirogyra setiformis*, var. *maior*;
a. part of a vegetative filament, x75;
b, c. part of the filament with zygotes and conjugating tubes, x80;
d. part of a Chlorophyll band, x550.

PLATE III

FIG. 3. Part of the thallus of *Cladophora glomerata*, var. *rivularis*, with the branches, x80.
FIG. 4. Portion of an older branch with lateral branchlets, x250.

FIG. 5. Portion of a filament with fructiferous cells, x300.
FIG. 6. An apical cell with spores, x250.
FIG. 7. Part of the plant mass, slightly magnified.

PLATE IV

FIG. 8. Part of the filament of *Cladophora crispata*, var. *genuina*, with subdichotomous branches, x100.
FIG. 9. Portion of basal filament, x75.
FIG 10 Portion of filaments with unilateral branches, x100.
FIG. 11. An intermediate cell with its spirally reticulate Chloroplast, x400.
FIG. 12. Part of the filament of *Lyngbya Martensiana*, x600 ;
FIG. 13. Apical portion of the trichome, x600.

METHODS OF FISHING IN THE PUNJAB

BY

M. HAMID KHAN, M.SC.

(*Fisheries Research Officer, Punjab*)

(*With a plate*)

A. ILLEGAL METHODS.

The methods of fishing in the Province before the Fisheries Regulations came into force were innumerable, and most of these seemed to be devised with the express purpose of allowing nothing however small to escape. The following are some of the most harmful methods which have been instrumental in diminishing the supply of fish in the Province :—

(1) Poisoning.

(2) Dynamiting.

(3) Fixed Engines.

(4) Diversion of water for killing fish.

(5) Erection of dams, weirs, traps, etc., for killing fry and young fish.

(6) Continuous netting with small meshed nets.

Poisoning.—The Indian Fisheries Act IV of 1897 prohibited both poisoning and using explosives for the purpose of killing fish. The practice has, however, been prevalent throughout the Province, especially in the hilly tracts, and each year during the months of May and June when the streams are very low and all the fish congregate in what pools still remain, they are ruthlessly poisoned and wanton destruction, of not only the fish but of the tiny fry and the entire animal life which forms the food of the fish, is incalculable. The slaughter does not end in the pools, but as the water trickles out and down the stream carrying the poison with it, it takes its toll all along the stream for often a mile or more. The poisons used are :—

(i) Lime.

(ii) The juice of the Cactus or *Thohar* (*Euphorbia royleana*) also called *Chhui.*

(iii) Pounded *Tirmal* seeds (*Xanthoxylum aletum*).

(iv) *Chila* seeds (*Cascaria tormentosa*).

(v) Boiled tea leaves mixed with lime.

These poisons called *Mohan* are thrown into pools and there stirred up and made to mix with the water by men swimming in the pool and stirring the water with bamboos. The water becomes milky, and about an hour or less after the poison is thrown in, the fish come to the surface stupefied or dead. No bad effects are produced by eating them.

Dynamiting.—Notwithstanding the dangers to which the offender is exposed dynamiting is still indulged in. Many accidents have

occurred. Fish become stupified or dead due to sudden explosion in the water and are picked up.

Fixed Engines.—*Urli* is a conical shaped contrivance of basket work. It varies in depth from 4 to 6 feet, the mouth being at the broader end. A dam is made across a stream with one aperture into which is fitted the mouth of the *Urli* on the downstream side. The narrow end is sunk in the stream. All fish dropping down the stream must necessarily be carried into the *Urli*. The force of the stream pouring into it prevents the fish from escaping. It destroys large number of small fry.

Jari is of two kinds—

(i) A drag net is fixed across the stream with its lower end fixed at the bottom, while the free upper end projecting out of the water is turned back and supported on sticks. Another drag net is joined at its lower end with the fixed end of the first net, while its free end is turned back to face the free end of the former net, and is supported on sticks and lies submerged under water. There is hardly three or four inches water above the second net and two or three yards distance between the free ends of both the nets. Fish passing over the submerged end of the second net fall into the pockets of the first net and cannot find their way out. They soon tire themselves and are then taken out by the fishermen.

(ii) A second kind of *Jari* is just like a big mouse trap. It is made of two big bag-like nets fitted into one another. The first net's mouth, supported by sticks, is fixed across the stream. Posteriorly it has got another aperture with a wooden ring opening into the second net, which encircles the posterior half of the first net and is free posteriorly. Its free posterior end has got an opening which is kept closed and is opened whenever it is desired to take the fish out. Fish get into the first net through the mouth and then pass into the second net through the posterior opening and there they are caught like a rat.

Erection of dams, weirs, traps, etc., for killing fry and fish—

(i) *Trop.* A very impenetrable fence of thorn is made across the stream, and behind a net like *patti* (stake net) is stretched horizontally supported by means of four sticks one on each end. The fish going down or coming up the stream see the fence and try to jump over it and are caught in the net.

(ii) *Patal, Dhingri* or *Adhani*. Thorny branches are fixed across a stream, leaving some clear area near the banks. The fish on finding their way obstructed by the fence try to pass along the sides near the bank and are then caught by fishermen with casting net.

(iii) *Dhap*. An open mouthed vessel just like a platter of any metal or of earth is taken. A ball of flour is placed in the middle of the vessel. The vessel is then wrapped in white cloth and a hole is made in the cloth just above the ball of the flour, and then placed at the bottom of the stream. The fish being enticed by the flour begin to enter through the hole. The owner of the vessel remains on the lookout and when he sees that sufficient number of fish have entered in the trap, he goes slowly, puts his hand on the hole, and brings out the vessel. Then he unties the cloth and takes out the fish.

(iv) *Batarru.* Stones are placed in the stream near the bank in a circle, surrounding a hollow. The fish in summer come to take shelter there. The fisherman covers these stones with a net and kills every fish. This method is very harmful for young Mahsir.

(v) *Dhanu.* Holes are made in the dams of the Kuhls (streamlets diverted for watermills) and the water passing through them is allowed to fall on a stony platform. The platform is covered all round with stones. The fish going through these holes are deposited on the platform, and are taken out of it by putting the hand through a hole kept in some convenient place. It ensures a fresh and ready supply to the owner.

Continuous netting with small meshed nets—

(i) *Dou.* It is a small but very fine meshed net, having two sticks, one on the right and the other on the left side, and a few sinkers in front. It is held in both hands and used in disconnected pools.

(ii) *Sambi* resembles *Dou,* but is bigger in size and is used in catching *Chilwa.* It is a triangular-shaped fine meshed net with two bamboos twelve feet each, one on each side and a well stretched, tight cord in front. The net can be used by single man who holds it at the apex. Generally, however, two men use it, each holding the bamboo on the side. When *Chilwa* run up the river in shoals the *sambi* is fixed at places where a small whirlpool is formed near the bank. Men hold the net in front and face the fish. When fish reach the whirlpool they are forced into the net by the whirling current. A *sambi* is sometimes lifted with many pounds of fish in it. With one *sambi* 400 to 600 pounds of fish have been caught in one day.

B. LEGAL METHODS.

In addition to the prohibition of poisoning and dynamiting under the Indian Fisheries Act IV of 1897, fishing in the Punjab has been restricted under the Punjab Fisheries Act II of 1914 and is only permitted under a licence by any of the following methods :—

(1) Drag net used in conjunction with stake net (i.e. *Bhiga, Kadh, Kurga, Chhatta* or *Mahjal*) with a minimum mesh of 1¼ inches square or 5 inches all round in the hills and 1½ inches square or 6 inches all round in the plains.

(2) Fixed nets, e.g. *Nilotu, Pand,* etc.

(3) Casting nets, e.g. *Sotwan, Palku, Dobajju, Weru, Soru* or *Pakha.*

(4) Hand nets, e.g.—
   (i) *'Kochbi' and 'Saggan'* with prescribed mesh of one inch square or 4 inches all round.
   (ii) *'Dhangla'* with 1½ inches square mesh or 6 inches all round.

(5) Dip net, e.g. *Kurli* or *Khonche.*

(6) Fixed Engines, e.g.—
   (i) *Chip* and *Chipli;*
   (ii) *Bar patta* or Stake net.

(7) Lines—
   (i) Long line with hooks (*Lang* or *dor*).

(ii) Hand Line (*Dori*).

(iii) Rod and Line (*Bansi, Birhi, Chheep*).

(8) Horse hair noose or *Kalerni.*

(9) Grains or Spear (*Bhalla* or *Tiri*).

Drag net.—It varies in length from 13 to 15 feet and in depth from 9 to 12 feet. The universal method is to fix a stake net (*Banda*) athwart the current at the tail of the pool, and to work a drag net gradually down the pool by a line of men swimming, diving, working *sarnais* (inflated skins) and doing all they can to drive the fish before them. Weights are attached to the lower end of the net, so that at the time of drawing it downstream, the lower end should remain close to the bottom, and should not permit any fish to escape. Sometimes two or three such drag nets are thus worked one behind the other. Another method is to fasten twenty or more drag nets so as to form a seine (*para*) which is shot from one bank of the river when the river is low.

Fixed nets.—

(i) *Nilotu* or *Pand.* This net is smaller than the drag net. It is fixed in pools in certain places which the fisherman knows by experience to be the favourite resort of the fish. The net is placed at night, the bottom resting on the bed of the pool, and the upper edge on the surface, and is removed in the morning. Fish leaving their strongholds or returning to them during the night are frequently caught by the head in the net.

(ii) The *Nara* is 100 feet or less in length and 6 feet in depth. There are no sinkers or weights at its bottom, and it is kept floating by *naras* i.e. short, hollow, bamboo sticks or reeds attached to its upper end. It is fixed at one end of the pool whether shallow or deep, and men from the other end frighten the fish by throwing stones or by swimming and diving and drive fish towards the net where they are caught.

Casting nets.—There are different local names given to casting nets of various meshes :—

(i) *Sorru* : having ½ inch square mesh.

(ii) *Werru* : having ¾ inch square mesh.

(iii) *Dobajju* : having one inch square mesh.

(iv) *Palka* : having 1¼ inch square mesh.

(v) *Sotwan or Pakha* : having 1½ inch square mesh.

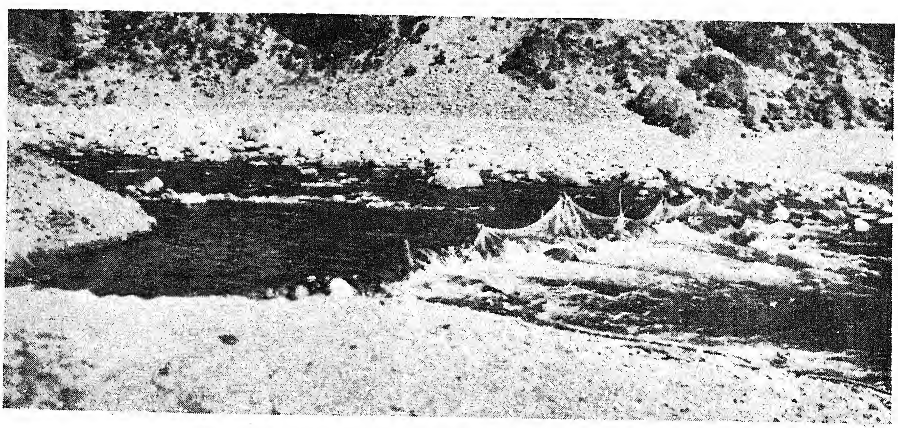
The diameter of the net when extended by casting varies from 3 feet to 16 feet. It is circular in form, with weights attached to its circumference. In using it the fisherman wades into shallow water and throws the net with a rotatory movement some 5 or 6 feet away from him, holding it by a cord. The net spreads itself and is carried to the bottom by the weight of the sinkers. Casting nets, used on sandy bottoms in the plains, have puckering strings (*sag*) while those used in the hills are devoid of them.

Fishing with casting nets is very common in the Province and various methods are employed to entice the fish. For example—

(i) During the months of March, April and May the fisherman finds a place near the banks of the river where cowdung is in abundance. There he fixes a small stand of three sticks in water and places a small hand-made lamp with wick and oil on the stand, and

1.—Drag Net and "*Kurli.*"

2.—Fixed Net (*Nara Jál*).



3.—Stake Net (*Bar Patta*).

METHODS OF FISHING IN THE PUNJAB.

lights it during the night. Flies and moths from the cowdung are attracted by the light in large numbers. Their wings are burnt and they fall into the stream and are carried down by the current. Fish find the delicious morsels and are consequently attracted to the place wherefrom they are coming. The fisherman with a casting net sits on watch and as soon as large number of fish have collected near the light he throws his net and gets a good catch.

(ii) Catching Bachwa (*Psuedeutropius garua*).

Small fish (*Chilwa*) are caught and placed in an earthen vessel without any water and decomposed. They soon begin to smell foul. Some sticks projecting 2 or 3 feet out of water are fixed in places where *Bachwa* are known to abound. To the free ends of the sticks are attached some bunches of cords sufficiently long to trail in water, and to these cords are tied the decomposing *Chilwa* as bait. Their smell attracts the fish which come in large numbers to devour the bait. At that time the fisherman wades into water and covers the whole lot with a casting net and takes them out.

Hand nets—

(i) *'Kochbi'* is a bag net, circular in form, about 3 feet in diameter and the same in depth, with a bamboo handle about 3 feet long. The *'Saggan'* has a deeper pocket, a greater diameter and a slightly longer handle, and is either circular or triangular in form. These nets are generally used either (*a*) near falls for catching fish ascending during the months of March to June, or (*b*) during floods to take spawners or small fish which take shelter in eddies and breakwaters close to the banks.

(ii) *Dhangla* is a combination of dip and drag nets. It is a rectangular piece of net, with a stick, 3 or 4 feet long, on each of the smaller sides to serve as handles and tight cords on the lower and upper sides. Two men, one on each side, drag it in small streams or shallow waters.

Dip nets.—*Kurli* and *Khonche* are used in shallow waters. The *Kurli* is said to derive its name from *Kurl* (Fish-Eagle) as it is put on the fish in manner similar to the swoop of the Fish-Eagle. It is conical in shape, and is made of 4 sticks tied together at the top, and with a circular piece of net, fastened to the free ends of the sticks at the broad end. *Khonche* is a conical basket.

Fixed Engines—

(i) *Chip.*—A *Chip* is a platform of split bamboos or sticks, interwoven or tied together in such a way as to leave interstices of 1½ inches square between the sticks. The platform is erected under a fall natural or artificial, in such a way that the portion furthest from the fall is higher than that directly under the fall, i.e. the whole platform slopes upwards on the downstream side. The portion between the fall and the platform is extended to well below the fall so that none of the fish can drop through. All the fish coming down the stream must necessarily fall on to the platform. The little ones and the water run through the interstices leaving the bigger fish high and dry on the platform. In the past, the interstices were carefully filled up with grass so that nothing could escape, but as the punishment for this bit of sharp practice is a fine with the addition of forfeiture of the licences and the destruction of

the *Chip*, it is not much indulged in now. As a *Chip* is built in a narrow portion of the stream, and the entire stream practically flows over it there is not much that can escape it. The fee for the *Chip* is Rs. 12 per season, and as many villagers as please can be partners therein. The *Chip* is erected towards the end of monsoons, and accounts for mostly spent fish (i.e. those which have spawned) and those descending the streams with the fall in the volume of water.

(ii) The *Chipli* is a *chip* in miniature. Its use is permitted in places for the capture of *Chilwa*.

(iii) *Bar Pattas* (Stake nets). A stake net with a minimum mesh of 1½ inches square or 6 inches all round is fixed across a stream with stones and perpendicular stakes only. The net is kept lower in height near both the banks. Fish working down to the river after the rains are caught on these *Bar Pattas*. The fish on finding their way obstructed by the net try to pass through along the sides near the bank, and are there caught by the fisherman with casting net. *Bar Pattas* are erected for three and a half months from 1st August to the 15th November each year.

Lines.—Long Line with hooks (*Lang* or *dor*) is set across a river or Jhil, and has as many hooks as can be tied at six inches intervals. Baits used are generally earthworm, chilwa and larvae of dragonflies.

Hand Line (*Dori*) has one or two hooks at the end with a sinker. Hooks are baited and line thrown into water. It is generally used to catch ground feeders.

Rod and Line (*Bansi, Bīrhi* or *Chheep*) is universal method of catching fish, and is becoming very popular in the Province. The following portions of the rivers in the Province have been reserved for Rod and Line fishing only :—

Kangra District—

(i) Beas River and its tributaries from the source of the Beas to the milestone 'Kulu' 2 near the old Akhara Bridge, the Sarbari River and its tributaries, from the source of the intake of the Tahsil Kuhl, the Sainj River and its tributaries, and the Tirthan River and its tributaries from and above its confluence with the Jibi stream in so far as they are situated within the jurisdiction of the Assistant Commissioner, Kulu.

(ii) Baner stream and its tributaries from its source down to near the shop in Jia village.

Rawalpindi District—

(i) The Kurang River from Rawal waterfall down to the Kurang Railway Bridge, and

(ii) The Sohan River from the old Railway Bridge Piers to the tail of Jalalia pool below Shahpur village.

Lahore and Sheikhpura Districts.—Within a distance of ¾ of a mile on either side of the Road Bridge over the Ravi River between Lahore and Shahdara.

For all Districts.—Within a distant of one hundred yards from any bridge.

Canal Head Works.—

(i) Jehlum River from one mile upstream to ½ mile downstream of the Mangla Head Regulator;

(ii) Jehlum River from $1\frac{1}{4}$ mile upstream to $\frac{3}{4}$ mile downstream of the Rasul Weir.

(iii) Chenab River from one mile upstream to $\frac{1}{2}$ mile downstream of the Marala Weir.

(iv) Chenab River from $1\frac{1}{4}$ mile upstream to $\frac{3}{4}$ mile downstream of the Khanki Weir.

(v) Ravi River from one mile upstream to $\frac{1}{2}$ mile downstream of the Madhopur Weir.

(vi) Ravi River from one mile upstream to $\frac{1}{2}$ mile downstream of the weir at Balloki.

(vii) Ravi River from $\frac{1}{2}$ mile upstream to $\frac{3}{4}$ mile downstream of the Sidhnai Weir.

(viii) Sutlej River from upstream end of Spur No. 2, $1\frac{1}{4}$ miles above Rupar to $\frac{1}{2}$ mile downstream of the weir.

(ix) Right Bank of the Jumna River from Cross Section No. 1 marked at the sight of Hathni Kund Gauge upstream of the Tajewala Weir down to the Cross Section No. 14, near Mandewala Village downstream of the Weir which lies within the Punjab.

(x) Somb Nala from $\frac{1}{4}$ mile above Spur A upstream of the level crossing down to the confluence of the Nala with the River Jumna near Dadupura.

(xi) The Western Jumna Canal from half a mile above to half a mile below the Dadupur Regulator.

(xii) Sutlej River from one mile upstream to $\frac{3}{4}$ mile downstream of the weir at Ferozepur (Gunda Singh Wala).

(xiii) Sutlej River from one mile upstream to $\frac{3}{4}$ mile downstream of the weir at Suleimanki.

Horse Hair Noose or *Kalerni*.—A horse hair noose or *Kalerni* is used in Kangra District just after the rains for catching small variety of fish, e.g. *Kurka* (*Garra lamta*), *Tatler* (*Cirrhina latia*) and others. It is a kind of a trap made in the form of a horse hair noose, and is put under water the depth of which does not exceed three feet.

Grains (*Tiri*) or *Spears* (*Bhala*) are used in shallow waters. *Tiri* is a kind of harpoon with four or five barbed points.

DESCRIPTION OF A NEW ANT-MIMICKING SPIDER, *SYNEMOSYNA TRANSVERSA.* sp. nov.

BY

DURGADAS MUKERJEE,

Lecturer in Zoology. Calcutta University.

(*With 2 text-figures*).

Synemosyna transversa, sp. nov.

No ant-like spiders of the group *Synemosyneæ* [1] are so fai known from India, though a few species of the genus *Synemosyna* Hentz (Silliman's *Amerc. Journ. Sci. Art.* xxi, p. 108, 1832) have been recorded by Thorell[2] from Burma. In 1927, while collecting ants from Barrackpore I came across a single female spider belonging to the genus *Synemosyna*, in company with the ants *Diacamma vagans* (Smith) and *Componotus sericeous* (Fabr.). The spider showed a striking resemblance to the Ponerine ants in possessing a constriction in the abdomen, a node in the pedicel and in its cephalo-thorax being separated into a broad head and a convex thorax. The specimen does not conform to any previously described species, and is described below under the name *Synemosyna transversa*.

Female, length—5 mm.

The dorsal surface of cephalic area (Fig. 2) which is bounded by the anterior and posterior rows of eyes, is flat and broader than long; the sides are clothed with short hairs. The eyes are arranged in three rows. The anterior row is recurved, and the eyes in this row are equally spaced; the distance between the centrals is the same as that between the central and the anterior lateral. The anterior central eyes are the largest in diameter and about two and a half times the diameter of the anterior lateral eyes. The middle row is nearer the anterior row; the third row is situated near the posterior margin of the cephalic area and these eyes are as wide apart as the cephalo-thorax at that place. The palp is longer than the cephalic area. The digital joint is larger than the radial. The cubital is shorter than the radial. The cheliceræ are vertical and pluridentate.

The cephalo-thorax is divided by a deep transverse constriction into the cephalic and the thoracic regions (Fig. 1). The cephalic region is as broad as long, while the thoracic region is longer than broad and exceeds the cephalic region in length. The thoracic region is convex above and its posterior edge near the pedicel is slightly turned upward. The cephalo-thorax is pubescent,

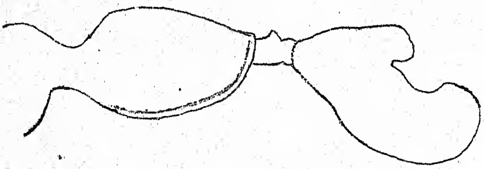


Fig. 1. *Synemosyna transversa*, sp. nov. Lateral view of the thoracic and abdominal regions. The anterior portion of the cephalo-thorax not shown.

and the dorsal surface of the thoracic region in the middle bears two long hairs. The pedicel is a little longer than broad and is about half the length

[1] Simon, E , *Hist. Nat. Araignées*, (*Paris* 1897), T. ii, pp. 508–512.

[2] Thorell, T., *Spiders of Burma* (*London*, 1895), pp. 320–322, 325 and 328 and *Ann. Mus. Civ. Stor. Nat. Genova.*, xxv, p. 339, (1887).

of the distance between the anterior and the third row of eyes. The pedicel possesses a small flat node at its middle. The abdomen is oval in form and

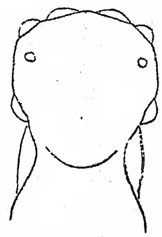


Fig. 2. Dorsal view of the cephalic region.

a little longer than the thoracic region ; it is clothed with a silky pubescence while the pilosity on its posterior region is dense. The sides of the abdomen are rugose.

A deep and broad transverse groove separates the anterior third of the abdomen from its posterior portion. The dorsal surface of the abdomen lying in front of the transverse groove is depressed between its dorso-lateral surfaces and its posterior edge overhangs the transverse groove. A longitudinal groove is present on the ventral surface of the abdomen and extends from the posterior limit of the epigynum to as far as the spinnerets.

The legs are slender, 4, 3, 1, 2. The femur of the last pair of legs is the longest, and its tibia and protarsus are subequal. The legs are furnished with spines ; those on the protarsus and tarsus being very numerous and densely situated.

The dorsal surface of the cephalic area, which is bounded by the eyes, is reddish brown. The sides of the cephalic region and the whole of the thorax are brownish-black, while the abdomen is black. The coxae and the trochanters of 2nd, 3rd and 4th pairs of legs are black. The femur, patella and tibia are fuscous, while the other portions of the legs are yellowish-brown.

The type specimen is preserved in the Museum of the Zoological Department of the University of Calcutta.

TWO NEW SPECIES OF *SPHINGIDÆ* (HAWK MOTHS) FROM THE ORIENTAL REGION

BY

C. E. FELLOWES-MANSON

The two new species of Sphingidae which are herein described have been acquired from me by my friend, Mr. B. Preston Clark, of Boston, Massachusetts, U.S.A., who is as keen a collector of *Sphingidæ* as myself. Mr. Preston Clark originally described them in the *Proceedings of the New England Zoological Club*, Vol. ix, pp. 17-19, Cambridge, Massachusetts, May 1, 1924. As it is impossible for me to improve upon his able descriptions, I will take the liberty of quoting them verbatim, and adding other notes of my own. I also take this opportunity of acknowledging with thanks the honour he has conferred upon me by naming these two new Sphingids after me. The specimens were previously shown to Lord Rothschild and Dr. Karl Jordan, M.A.L., Ph. D., at the Tring Museum, Herts, England, who kindly examined them, and not only pronounced them to be new species but also very remarkable forms, especially *Compsogene mansoni* (Clark), a large species measuring 160 millimetres in expanse. Previous to its discovery there was only one other known species in this Genus, viz. *Compsogene panopus* (Cramer), the larva of which feeds on the leaves of the Mango (*Mangifera*). The discovery is therefore highly interesting.

Compsogene mansoni, sp. nov.

Compsogene mansoni Clark, Proc. New Eng. Zool. Club, vol. ix, p. 17. Cambridge, Mass. (1924).

'Al. ant. long., ♂, 70 mm. Al. ant. lat. ♂, 24 mm. Marg. ext., ♂, 36. mm.'

'*Habitat.*—Sikkim, North-Eastern India. One male (the type) in collection B. Preston Clark, collected by Mr. C. E. Fellowes-Manson, and acquired by me from him. This specimen lacks antennae, is faded, and in very poor condition.'

'Palpi yellow, bordered with brown along the eye and to the tips. Thorax and posterior portion of the abdomen above darker brown than the anterior portion of the abdomen, as in *C. panopus* (Cr.).

'Forewing above:—A light brown basal area extends from a point on costal margin 36. mm. distant from the wing base to a point on the inner margin 21 mm. from the base, and includes the entire area basad of these points.'

'This basal area has within it three heavy sub-basal angled lines along costal margin, 3, 6 and 9 mm. distant from the base, continued irregularly and obscurely towards inner margin. There are also within this basal area two angled lines on costal margin, 22 and 25 mm. distant from the base. From the posterior of these lines extends an irregular band roughly parallel to the basal edge of a dark brown median area; this band is interrupted at the veins and extends to the inner margin. The dark brown median area extends straight across the wing basally, more obliquely than in *C. panopus*. On the costal margin it is 11 mm. in width, thence it broadens to a width of 16 mm. on R1. Between R1 and R2 it narrows sharply to 6 mm. Its narrowest point is between R2 and R3, where it is but 5 mm. wide. From this point it broadens to the hinder angle, where it is 14 mm. in width. Within this area, between M_2 and SM_2 and extending somewhat beyond M2, is a black area, which lacks the five white lines basad of it of *C. panopus*.'

'The apical portion of the wing distad from the dark brown median area is light yellow, slightly irrorated with brown, with a darker marginal band extending from SC5 to hinder angle. This marginal band is a mere line at SC5, but broadens regularly to a point between R1 and R2, where it is 4·5 mm. in width, thence it narrows to M2; from M2 to hinder angle it is hardly more than a marginal line. Distal border of wing between SC4 and SC5 is blunt.'

'Forewing beneath; Basal half light yellow, sub-basally dark brown, and including an irregular, brown line roughly parallel to the basal margin of a dark median area. This, broadens to a roughly rectangular area within the apical portion of the cell. The dark brown median area follows in general the form of that on the upper side of the wing, as do the light yellow apical area and the marginal band.'

'Hind wing above: Light yellow with very dark brown markings. The wing is crossed by four distinct bands. The first is antemedian, narrow, curved basad costally. The second, median, broad (2 to 4 mm.), irregular, widest at R1. The third, narrow, made up of lunulate lines between the veins, from anal margin to R1; from R1 to costal margin it is broader and continuous, curving basad. The fourth line is marginal at the anal angle, and narrow; it broadens continuously to the costal margin, where it is 4 mm. in width, and 5 mm. distant from the wing apex. Between these bands the yellow ground tone of the wing is sparsely irrorated with brown.'

'Hindwing beneath: Light yellow with dark brown markings, which roughly duplicate those on the upper side of the wing.'—(B.P.-C.).

Habitat.—Sikhim, N. E. Himalayas

Localities.—Darjeeling District, Brit. Sikhim.

Elevation.—(altitudinal range).—7,000 ft. (at electric light).

Months of appearance.—June.

Comparative abundance.—Extremely rare. There is only one known specimen (the type) in coll. B. Preston Clark.

Expanse.—♂ 160 mm. ♀

♀ and early stages not known. The ♀ larva most probably feeds on the leaves of a wild species of *Mangifera* (Mango). It is doubtful if this tree grows in Sikhim at a higher elevation than 3,000 to 4,000 ft. and my opinion is that the specimen I captured at the electric arc lamp in Darjeeling 7,000 ft. elevation must have been attracted by its brilliant light from a much lower elevation than this.

Theretra mansoni, sp. nov.

Theretra mansoni Clark, Proc. New Eng. Zool. Club, vol. ix, pp. 18–19 Cambridge, Mass. (1924).

'Al. ant. long., ♀, 31 mm. Al. ant. lat., ♀, 16 mm.
Marg. ext., ♀, 23 mm.'

'*Habitat.*—Sikhim, North-Eastern India. One female (the type) in coll. B. Preston-Clark collected by Mr. C. E. Fellowes-Manson, and acquired by me from him. This specimen is in very poor condition, lacking both antennae and abdomen, but its characters are sufficiently well marked to make a description possible.'

'This species is nearly related to *Theretra alecto* (Linnè) and to *T. suffusa* (Walker), being closer to the former species.'

'Head and thorax above dark brown with no median line, both as in *T. alecto*. Side stripe along the head and thorax as in *T. alecto*. but less brightly white; duller in colour with a pink tinge. Thorax beneath gray in median area and pink laterally.'

'Forewing above: Cilia pink with brown tips. Ground tone wood-brown; a darker wood-brown marginal band extends from the wing tip to hinder angle, widening evenly to this angle, where it is 9 mm. in width. This marginal band is made of three, the distal one exceeding in width the other two, and the three separated by light brown lines. Basad of this marginal band the wood-brown of the entire wing area becomes lighter in tone as it approaches the marginal band. Inconspicuous light brown stigma with dark dot in its centre. Black and white basal tufts as in *T. alecto*'.

'Fore wing beneath: Cilia pink. Basal half of wing wood-brown, this colour extending along costal margin to wing tip. Marginal band, similar in outline and in width to that of *T. alecto*, but a much darker wood-brown. Between the basal wood-brown area and the dark wood-brown marginal band is a light pink area, very narrow (2 mm. in width) between SC 5 and R2, and much broader (10 mm. in width) betwen R2 and SM2.'

'Hindwing above: In all respects similar to *T. alecto*, except that the wing is a deeper pink at anal angle. Cilia white.'

'Hindwing beneath: Cilia gray. Wing differs markedly from *T. alecto*. The latter form is unicolourous save for the marginal band. In *T. mansoni*

the marginal band and the entire basal half of the wing are wood-brown, the pink tone being broadly present towards anal angle and narrowing towards costal margin.'—(B.P.-C.).

Habitat.—Sikhim, N. E. Himalayas.

Localities.—Darjeeling District, Brit. Sikhim.

Elevation.—(altitudinal range).—7,000 ft.

Months of appearance.—June and July.

Comparative abundance.—Extremely rare. I only captured two specimens, a ♂ and ♀ of this new species; the ♂ specimen was very badly damaged and is not now in existence; so there is now only one known specimen (the type) a ♀ in coll. B. Preston-Clark.

Expanse.—♂ 76 mm. ♀ 82 mm.

Early stages not known.

Both these specimens were captured at an electric arc lamp in Darjeeling, 7,000 ft. elevation, but may have been attracted from a lower or higher elevation than this.

THE HISTORY AND PROGRESS OF THE ZOOLOGICAL SURVEY OF INDIA

PART II

(*Continued from page 930 of Volume XXXIII, No. 4*)

INVERTEBRATE SECTION

BY H. SRINIVASA RAO, M.A., D.SC.

The Invertebrate Section of the Zoological Survey of India (formerly the Natural History Section of the Indian Museum) includes a large assemblage of mostly small terrestrial, freshwater, brackish-water, and marine animals belonging to various Invertebrate groups of Phyla other than the Arthropoda and the Mollusca. The Arthropod and Mollusc collections are in charge of three officers who look after the Sections of (1) Insecta, Arachnida and Myriapoda, (2) Crustacea, and (3) Mollusca respectively. The other Invertebrate collections of the Animal Kingdom are in charge of a fourth officer, and include those belonging to the groups Porifera (Sponges), Coelenterata (Corals, Hydroids, Medusæ, Sea-Anemones, etc.), Echinodermata (Sea-urchins, Brittle-stars, Sea-cucumbers, etc.), and 'Vermes'—the last named being a convenient though arbitrary term used to designate a varied assemblage of worms (free-living and parasitic) and other forms of animals, some closely, and the others remotely, or not at all allied to the worms proper which also include members of the Phylum Annelida.

In the introductory part of the article by Col. Sewell reference has been made in general to the sources from which the Zoological collections of the Survey have been derived.[1] It is unnecessary to enumerate them again here, but it may be mentioned that so far as the Invertebrate Section is concerned the part played in the acquisition of zoological collections by the Asiatic Society of Bengal, by private donors, and by the various political and military expeditions, has been, comparatively, small. Zoological material obtained from these sources consisted chiefly of terrestrial and aquatic Invertebrates, many of them not belonging to groups of the section with which the present account deals. It was not till after the Royal Indian Marine Survey Steamer 'Investigator' actually started biological work in Indian seas that the Invertebrate collections began to accumulate and gain in importance.

It will be convenient to deal with the Invertebrate Section in two distinct parts, (i) the terrestrial, freshwater and brackish-water

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[1] For full details on this subject reference may be made to the article by the late Dr. Annandale on the zoological collections in a book entitled *The Indian Museum*, 1814-1914 (Calcutta, 1914) published in commemoration of the centenary celebrations of the foundation of the Asiatic Society's Museum which later developed into the Indian Museum.

collections, and (ii) the marine collections, as the history of the one is different from that of the other.

The study in India of the Invertebrate animals referred to in this section may be said to have commenced in 1847 with the late Dr. H. J. Carter of the Bombay Medical Service, who laid the foundation for the study of fresh water sponges in India. His work on freshwater Invertebrates was continued by the late Dr. F. Stoliczka whose varied interest in zoology led him to study other groups of animals besides sponges, and especially those living in brackish water areas. The work of these pioneers in fresh and brackish water Biology was greatly extended by the late Mr. J. Wood-Mason, Col. A. W. Alcock, and the late Dr. N. Annandale; all three of them were, it may be noted, intimately connected with the Indian Museum by virtue of their office as Superintendents.[1]

The fresh-and brackish-water, as well as the terrestrial, collections consist of animals belonging chiefly to the groups Porifera, Polyzoa, Hydrozoa, Hirudinea, Oligochaeta, and Platyhelminthes. Those of the first three groups are found both in fresh- and brackish-water areas, and in the sea. The fourth consists of land and aquatic forms, some of them predaceous or parasitic in a wide sense. The fifth and the last named groups include aquatic and terrestrial forms, some of the latter group including internal parasites of animals and plants. The very rich collections of animals included in this section we owe in part to the sources mentioned above, but for the most part, to the enthusiasm and enterprise of the late Dr. Annandale, who with the help of his colleagues in the Indian Museum and later in the Zoological Survey and of the associates in India and abroad caused extensive collections to be made. Dr. Annandale was himself a very keen field-zoologist, and in the course of his official and private tours in Asia and Europe collected a large amount of material for this section. With the increased touring, which the officers of the Zoological Survey of India have been enabled to do in recent years, the collections in this section have been considerably augmented. It will perhaps be of some interest to note that the volume or extent of a collection has apparently varied with the workers available and their choice in the matter of groups to which they have devoted special attention. For instance we have in the Zoological Survey a large collection of Sponges and Polyzoa on which the late Dr. Annandale did very valuable work at the beginning of his career in the Indian Museum. In recent years additions to this part of our collection have been small in comparison. We have again a very large collection of earthworms and other aquatic Oligochaetes, chiefly as a result of the unceasing devotion to this group of Lt.-Col. J. Stephenson of the Edinburgh University (for many years Professor of Zoology in the Government College, Lahore) who has worked out the great bulk of our Oligochaetes, and is still continuing the work. Similarly

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[1] The advances in our knowledge of the fresh and brackish water fauna of the Indian Empire were summarised by the late Dr. Annandale in two papers, the *Journ. As. Socy. Bengal,* N.S. viii, pp. 39-52 (1912) and xviii. pp. 527-533 (1922).

we owe our collection of parasitic Helminthes to the interest evinced in this group by Dr. T. Southwell, late Director of Fisheries in Bengal, who was intimately associated with the work of the Zoological Survey, and by Dr. H. A. Baylis, of the British Museum, London, an authority on Nematodes. The large named collection of Leeches in this section is due mostly to the enthusiasm of specialists like Drs. Kaburaki, Oka, Profs. Harding and Moore, who have always been eager to study Indian material. The volume of work done on these groups has been of such great importance that the results of the studies of some of these specialists have been, or will be, embodied in the 'Fauna of British India' series.[1] Other monographs, as for instance the one on Indian Cercariæ by Col. Sewell[2], have been prepared entirely in India based on fresh material obtained in the field. Special volumes of the 'Records' and 'Memoirs of the Indian Museum' dealing with the fauna of definite regions in the Indian Empire also contain several valuable papers on the Invertebrates. A few among these are on the fauna of the Chilka Lake in the Madras Presidency, of the Inlé Valley in the Southern Shan States of Burma, and of the Siju Cave in Assam.

The history of the marine Invertebrate collections in the Zoological Survey may be said to date virtually from 1875 with the appointment of the Surgeon-Naturalist to the Royal Indian Marine Survey Steamer 'Investigator'. It must, however, be mentioned that previous to this appointment the late Mr. J. Wood-Mason, Superintendent, Indian Museum, carried out biological investigations in the Indian seas in 1872-73. He visited the Andaman and Nicobar Islands and succeeded in making a large collection of marine animals not only in shallow waters, but also in depths varying from 50 to 300 fathoms. The pioneer work of Wood-Mason in the investigation of marine animals in Indian waters was continued by the late Dr. J. Anderson (also Superintendent, Indian Museum) who visited the Mergui Archipelago in 1881-82. The results of his investigations are embodied in his *Contributions to the Fauna of Mergui and Its Archipelago* published in 1889. Deep-sea investigation was, however, not undertaken till three years after the launching of the 'Investigator' in 1881. From 1884 upto 1926 the biological work of the 'Investigator' in Indian seas has been carried out, with several breaks due to war, etc., in close connection with the zoological section of the Indian Museum, and later the Zoological Survey of India.[3] The accumulation of the rich collections of marine organisms, particularly deep-sea Invertebrates of great

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[1] *Fauna of British India,* Fresh water Sponges, Hydrozoa and Polyzoa, by N. Annandale (1911).

Fauna of British India, Oligochaeta by J. Stephenson (1923).

Fauna of British India, Hirudinea by W. A. Harding and J. Percy Moore (1927).

[2] Cercariæ Indicae', *Ind. Journ. Med. Res.* X (Suppl. No.), pp. 310, 3 pls. (1922).

[3] A full account of the biological work of the 'Investigator' upto 1914 and of the contributions of the successive Surgeon-Naturalists to our knowledge of the marine fauna is given by Capt. Sewell (now Lt.-Col.) in 'The Indian Museum, 1814-1914' (Calcutta, 1914).

interest in the Indian Museum is in the main due to the energy and zeal of successive Surgeon-Naturalists among whom were, to mention only a few, Lt.-Col. A. W. Alcock, Lt.-Col. R. E. Lloyd, and Lt.-Col. Seymour Sewell. A large proportion of these collections was studied by zoologists in India and abroad. The value of these collections may be judged from the fact that several important monographs on various groups of animals were published from time to time; Col. Alcock was himself responsible for several of the monographs.

The Bengal Fisheries Steamer 'Golden Crown', and the Hughli Pilot vessels stationed near the Sandheads at the mouth of the Hughli river have also contributed largely to our collection of Invertebrates, particularly those characteristic of the shallower waters of the Bay of Bengal, and of the mouths of the Ganges. The Invertebrate marine fauna of the Indian coasts has been very little explored, but animals from a few isolated areas have been collected on different occasions chiefly by Surgeon-Naturalists to the 'Investigator'. The officers of the Indian Museum, and later those of the Zoological Survey have also contributed small collections from the Orissa coasts, the Andamans and the extreme south of the Madras Presidency.

Presentations and exchanges from individual Zoologists or Museums and Zoological institutions both in this country and abroad have brought together a fairly representative collection of Invertebrates.

It will be seen that the Invertebrate collections in the Zoological Survey have thus been brought together from various sources for over a century. But it was mainly due to the enterprise of Col. Alcock and the late Dr. Annandale that the greater part of the marine Invertebrate collections has been named by specialists, mostly from abroad. The Echinoderms, Sponges and certain groups of Corals have been specially studied and reported on. We have still a large collection of other Invertebrate animals waiting to be studied and named. In the words of the late Dr. Annandale we have to deplore in regard to our collections that in India 'the harvest is rich, but the labourers are so few'. Specialists in various groups of zoology are still so few in India that many of our collections have often to wait for years before any foreign workers can be induced to name them. But it must be said to the credit of the zoologists abroad that whenever their own work and time permit they are always ready to study and report on our collections. It is this willingness on their part to co-operate with us that has given the impetus to greater and better efforts in the work of extended survey in various regions.

The most important of the monographs published so far on the marine Invertebrates of the Indian Museum, particularly deep-sea forms collected by the 'Investigator' are 'The Indian Triaxonia' by F. E. Schulze, the 'Hexactinellida and Tetraxonida' by A. Dendy and M. Burton, the 'Deep-sea Madreporarian Corals' by A. Alcock, the littoral 'Madreporarian Corals of the Indian Museum' by G. Matthai, the 'Asteroids, Ophiuroids and Echinoids' by R. Koehler (Holothurians, in collaboration with C. Vaney), the Crinoids

by A. H. Clark and 'Alcyonaria' by J. A. Thomson and W. D. Henderson.

The sources from which the Zoological Survey used to obtain marine Invertebrates have been few in recent years. With the retirement of Major R. W. G. Hingston, the last of the Surgeon-Naturalists attached to the R.I.M.S.S. 'Investigator' the survey work since 1926 is at a standstill. It is hoped, however, that the post of a Naturalist on the 'Investigator' in the regular cadre of the Zoological Survey of India will be created at an early date by the Government of India to continue the valuable work done by successive Surgeon-Naturalists for the last fifty-five years. What material is obtained at present for the marine Invertebrate collections is due to the interest taken by the Hughli Pilots in obtaining specimens from the Sandheads in the Bay of Bengal, and to the officers of the Zoological Survey, who on account of other work are enabled to visit only occasionally regions where marine animals are obtainable without any costly equipment or apparatus.

I have been in charge of the Invertebrate Section since 1926, although my special group was the Mollusca. In the absence of Dr. Baini Prashad (the permanent officer in charge of Mollusca) on long leave in Europe from August 1925, the Mollusc Section was also in my charge upto April 1927. From the time of the breaking up of the Invertebrate gallery of the Indian Museum before the war upto its rearrangement in 1925 the reserve collections of the Invertebrate Section were never put in order except for an attempt made by Dr. F. H. Gravely before his connection with this department ceased. Work in this direction was commenced early in 1926, but was frequently interrupted owing to the inadequacy of skilled assistance, the pressure of other work, and frequent touring. The named collections of Polyzoa and Hirudinea were, however, rearranged, and a card catalogue of the species present in the collection was prepared. The reserve collections in other groups, some of them very large, have similarly to be put in order before catalogues can be prepared. With an increased staff of assistants it is hoped that this work will be completed in due course.

The study of the Scyphomedusae in the Zoological Survey collections was commenced in the early part of the year 1926, but unavoidable interruptions due to research on other more important problems retarded the progress of this work. It is, however, hoped to publish a report on this subject at an early date.

Since 1926 I have toured in various parts of India and Burma on an average for about four months in the year. Early in 1926 a visit was paid to the Pearl Fisheries at Tuticorin in South India conducted by the Fisheries Department of the Madras Government, and large collections of various marine organisms associated with the pearl banks off the coast of Tuticorin within a distance of twenty miles were obtained. When the whole collection is studied, it will be a valuable addition to our knowledge of the fauna peculiar to the pearl banks and to the littoral area along the Indian coasts.

The study of the fauna of brackish water areas commenced by Stoliczka, and so ably continued by the late Dr. Annandale for some years before his death, was resumed within the last three

years. With this object in view I visited the backwater at Vizagapatam (which is now being converted into a harbour) in May 1926, and made collections of the different organisms living in the backwater proper, and in channels and streams connected with it but subject to the tidal influence of the sea. The same area was again visited early this year when profound changes had been introduced in its contour and in the composition of its floor as a result of the progress in the construction of the harbour. The fauna was found to be appreciably poorer than it was three years ago, no doubt as a direct consequence of the continuous changes in the settled habitat of many groups of animals. The harbour when completed will be investigated again to study the changes in the character and composition of the fauna.

In October 1926 I was deputed to conduct a Mollusc survey of the Northern Shan States of Burma on behalf of the Pasteur Institute, Rangoon.[1] The survey was in connection with the enquiry relating to the probable spread of Schistosomiasis in Burma from the adjacent Chinese provinces on the Frontier, where the disease is reported to be common. During the earlier stages of its life-history the fluke parasite of this disease lives in the body of an aquatic or semi-aquatic snail, while the adult parasite is found in man. It is believed that only certain species of snails belonging to one family are capable of harbouring the larval stages of these parasites in parts of Eastern Asia. In 1924 a few cases of Schistosomiasis were reported among Chinese coolies from Yunnan, working at Namtu in the Northern Shan States and it was feared that if the particular species of intermediate host snail occurred in any part of the Northern Shan States the disease would spread rapidly in Burma. It was with a view to finding out whether any such carrier of the disease was present in the neighbourhood of the country where the disease was first detected that a survey of the freshwater and amphibious snails was undertaken. The survey was conducted for three months in various parts of the Northern Shan States, and more particularly along the Chinese Frontier and along the trade routes by which the Chinese coolies immigrate. Snails from every kind of habitat were collected in the living state and examined for the particular type of Cercaria. The results of the survey were negative, as neither the particular species of snail, and its nearest allies, nor the type of Cercaria associated with the spread of the disease was found. From a faunistic point of view, however, the collection of Molluscs proved of great interest and has been recently reported on.[2] It may be of interest to mention that a similar enquiry throughout India was undertaken by the officers of the Zoological Survey at the instance of the medical authorities in India in connection with the much-feared spread of the disease from Egypt and Mesopotamia by infected sepoys returning to India at the close of the war. The results of this enquiry were also negative in as much as the inter-

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[1] At a later stage in the Mollusc survey my colleague Dr. B. Chopra in the Zoological Survey joined my party in the Northern Shan States.

[2] Rao, H. S., *Rec. Ind. Mus.*, XXX, *pp.* 399-468, pls. xii-xiv (1928).

mediate host of human *Schistosoma* was not found in India, and the type of Cercaria implicated in the transmission of the disease failed to infect species of Indian snails closely allied to those which act as carriers in Egypt. The preventive measures, which the medical authorities were prepared to take to combat the spread of the disease at considerable cost to the Government, were, therefore, not taken as a result of the findings of the officers of the Zoological Survey.

A preliminary survey of the backwaters on the coasts of Cochin and Travancore States in South India was undertaken by the Zoological Survey in December 1927. The backwaters are extensive being over a hundred miles in length and over ten miles in breadth. They open into the sea in some places, but for the most part they are separated from the sea by a narrow strip of land along the coast. Several streams from the adjacent hills which become torrential during the S.W. monsoon empty themselves into the backwater in that season, but are also subject to tidal influence during the dry weather, from October to March. These backwaters are thus subject to violent changes in the salinity of water, and the fauna is, therefore, believed to be of considerable interest. As so little is known of the animal inhabitants of these waters a preliminary survey of the backwaters was conducted by me in collaboration with Mr. M. Sharif at various places. The collection seems to be of great interest, but unfortunately owing to the paucity of workers in India much of it will remain unworked for some time to come. Meanwhile further information on the nature of the fauna under different conditions will be collected and collections made at other times of the year.

In accordance with the policy of the Zoological Survey to confine its attention to definite biological areas in its investigations, a survey of the fauna of the Malabar Zone on the West Coast of India inaugurated by the late Dr. Annandale some years ago was continued in November and December last year. Dr. Baini Prashad and I visited the Belgaum and N. Kanara Districts of the Bombay Presidency and later on I surveyed the freshwater fauna of the Shimoga and Kadur Districts of Mysore State. Extensive collections have been brought back and will in due course be worked out by the officers of the Zoological Survey.

During the period I have been in charge of the Invertebrate section a few collections which had accumulated for a number of years have been sent out to specialists abroad who were kind enough to agree to examine and report on them. The large collection of Polychaetes from littoral seas on the coasts of India is at present being examined by Mons. P. Fauvel, an authority on Polychaetes, and it is hoped that his report will be ready for publication sometime next year. The whole of our Cestode collection has been sent to Dr. T. Southwell, who has under preparation a volume (on the Indian Cestodes parasitic in Vertebrates) for the 'Fauna of British India' series.

Our collections are still incomplete in many respects, and as a result there are wide gaps in our knowledge of the Invertebrate fauna of this country. The free-living worms belonging to the

groups Platyhelmia, Nematoda and Nematomorpha, the parasitic Trematodes,[1] the Hydroza, Actiniaria, Gephyrea and Polyzoa of the shallow seas on the coasts of India, are as yet very little known, though short papers on these groups have been published in the '*Records*' and '*Memoirs of the Indian Museum*'. I cannot, in concluding this brief review of our activities in the Zoological Survey, do better than appeal to those interested in the Natural History Society, in the words of that distinguished and keen zoologist, the late Dr. Annandale, 'to give us their support and to take a practical interest in our work; for scientific work, like other branches of human activity, if it fails to attract the sympathy of educated men, is in danger of becoming either a valley of dry bones or a slough of despond. Even those who are completely ignorant of the technicalities of any science can help us greatly by sending us specimens of the animals that occur in ponds, rivers or lakes in different parts of the Indian Empire, and nobody need hesitate to send us such specimens because they are common. Most animals that are rare in museums are actually common somewhere, in a state of nature: they only appear to be rare because no one has taken the trouble to collect them in the particular locality in which they abound.' What has been said above regarding the freshwater fauna of the Indian Empire is equally true of the terrestrial fauna in our vast jungles, in our extensive ranges of hills, and in our plains and desert areas, of the fauna of the sandy or rocky shores of the Indian coast, and of the brackish water areas. It will greatly add to the value of collections of animals sent to us if they are accompanied by notes, however brief, on the locality, the time and date of collection, on the nature of the habitat in which they were found, on the natural colouration of animals collected, and on any other interesting feature which strikes the collectors as of biological importance.

MOLLUSCA SECTION

By B. Prashad, D.SC., F.R.S.E., F.A.S.B., F.L.S., F.Z.S.

When in 1918 the offer of the services of the Zoological Survey of India for war work was definitely accepted in connection with the investigations of the Mollusc hosts of *Schistosoma*, it was decided that the time had come for an officer to be appointed to take charge of the Mollusc collections of the Zoological Survey and to carry out systematic work on the freshwater Molluscs of this vast territory. I was unofficially connected with this work from its inception, but it was not till April, 1920 when I was relieved from the charge of the Director of Fisheries of Bengal, Bihar and Orissa that I was appointed as the officer in charge of the Molluscs. In addition for a time I held charge of the Insect collections and other groups for which no officers existed in the cadre of the department.

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[1] In recent years the study of Helminthology in India seems to be receiving increasing attention, particularly in some of the universities of northern India.

The Mollusc collections which were transferred, together with all their other zoological collections, to the Zoological Survey by the Trustees of the Indian Museum in 1916, formed a very important part of the collections that had been acquired by the Trustees, but since 1883 when the Curator of Molluscs, Mr. G. Nevill, retired owing to ill health, no special officer was appointed to look after these collections. As a natural result not only had the collections in this section not been augmented as in other sections, but even in the library of the Indian Museum there were big *lacunæ* in the conchological and malacological literature.

As the history of Indian Conchology is intimately bound up with the development of the collection of Molluscs in the Indian Museum it will not be without interest to trace shortly its development. In the very early days of the Museum of the Asiatic Society of Bengal the Mollusc collections were not of very great importance, but it is of interest to note that in 1836 W. H. Benson, a member of the Bengal Civil Service and an enthusiastic and gifted Conchologist, prepared and published in the *Journal* of the Society a catalogue of the land and freshwater shells in the Society's Museum. Later in 1860, one of the first separate catalogues to be prepared and published of the collections in the same Museum was that of the Molluscs by Theobald. The collections at this time, as a reference to this catalogue shows, were neither very rich in numbers nor in species, but a very good beginning had been made. Benson and Hutton were two of the early pioneers, who began to study the land and freshwater Molluscs of India and the adjacent countries, such as Afghanistan and Baluchistan, and, in addition to presenting valuable material to the Society's Museum, started publishing a series of papers on these animals in the Society's *Journal* and in the *Gleanings in Science*. In 1841 Dr. T. Cantor, who had accompanied a diplomatic mission to Chusan, China, brought back a rich collection of animals from that area. His collection of Molluscs, which was one of the most important collections from this region, was worked out by Benson, and was added to the collections in the Museum of the Society; a report on it was published in the *Annals and Magazines of Natural History*, London, vol. ix, 1842, and later in the *Journal* of the Society in 1855.

In 1857 W. Theobald commenced a very valuable series of papers on the land and fresh water shells of India and Burma, and presented several series of new and rare forms to the Society and later to the Indian Museum. In 1870 in collaboration with the celebrated English Conchologist, Sylvanus Hanley, he started a comprehensive illustrated treatise on the land and freshwater shells of India under the title of *Conchologia Indica*. This work was issued in eight parts during the years 1870-1876, while the text of this joint work was supplemented in 1876 by the issue of Theobald's *Catalogue of Land and Freshwater Shells of British India*.

In 1860 the Blanford brothers began publishing a very important series of papers entitled 'Contributions to Indian Malacology' in the Society's *Journal*, and this series was continued by W. T. Blanford in the *Annals and Magazines of Natural History* and *Proceedings*

of *the Malacological Society of London.* This series culminated with the publication of the first volume on Indian land Molluscs in the *Fauna of British India;* owing to the unfortunate death of Dr. W. T. Blanford the work was left incomplete, but Godwin-Austen from the manuscript notes was able to complete it as a joint work in 1908.

In 1868 H. H. Godwin-Austen started a valuable series of contributions on the land shells of Assam and Eastern Bengal. For several years he published various conchological and malacological papers on Indian and foreign Gastropods in different journals both in India and abroad, but from 1882 onwards his energies were chiefly devoted to publishing a supplementary work to *Conchologia Indica* entitled 'Land and Freshwater Molluscs of India', in which the animals of the different species were studied equally with their shells. Up to 1920, three years before his death, he had published two complete volumes and the first part of the third volume, both text and plates, of this valuable work.

In 1869 F. Stoliczka laid the foundations of a systematic study of Indian animals in reference to their anatomy and physiology, and more particularly in connection with the Molluscs. He caused extensive collections to be made not only in various parts of India but as far east as Penang and Singapore, and started getting together excellent figures of the animals of different genera and species; the originals of these manuscript drawings are preserved in the library of the Zoological Survey, while some of these were reproduced in Godwin-Austen's works. His sad death at a very early age was a great blow to the cause of Indian Conchology and Malacology, but his monumental works on the classification of Molluscs in the *Palæontologia Indica* will always bear testimony to the great service he rendered to the study of these branches. His large collections were all bequeathed to the Indian Museum and are preserved in this institution.

The Museum of the Asiatic Society was transferred to the newly-erected building of the Indian Museum in 1875, though the collections had been transferred by an Act of the Legislature to the Government of India in 1866. Shortly after the transfer of the collections Geoffrey Nevill, one of the leading conchologists of the last century, was appointed Assistant Secretary and Librarian of the Indian Museum. In 1879 his designation was changed to that of the First Assistant to the Superintendent, and he was definitely placed in charge of the Mollusc collections. Before he became connected with the Museum, Nevill, in collaboration with his brother H. Nevill of the Ceylon Civil Service, had published a number of valuable papers on the marine shells of Ceylon and India, and had amassed a large and varied collection. On his joining the Indian Museum as the Officer in charge of the Molluscs the Trustees purchased his private collection, while he presented to the library of the Museum several rare and valuable treatises on Molluscs which formed part of his personal library. On taking charge of the Mollusc collections Nevill energetically started to classify the collections and prepare hand-lists. He further augmented the collections by purchase, by exchanges with collectors all over the world and by

encouraging amateurs interested in shells to present specimens to the collections of the Indian Museum. The names of the various contributors to the collections of the Indian Museum are published after the prefaces in each of the two volumes of the Hand-List of Mollusca which were published in 1878 and 1885. The two volumes were devoted to the Gastropoda and dealt only with the Pulmonates and Prosobranchiates. In 1883 Nevill, owing to ill health, resigned his appointment and the completion of the Hand-List has ever since been in abeyance. The indices to these volumes were prepared by W. Theobald and published in 1889. During his tenure of office Nevill further published a small fascicle containing detailed descriptions of various species of Ampullaridae and Viviparidae in 1877, as well as several papers on collections from different parts of India and adjacent countries in the *Journal of the Asiatic Society* and in other publications, and it would not be wrong to ascribe to him the leading position amongst the workers on Indian Conchology in the last century. The excellent condition in which the collections in the Indian Museum were found, even roughly forty years after his retirement, bears testimony to the care with which he had arranged the material under his charge.

Before passing on to the work on the Mollusc collections within recent years, a reference is necessary to the great service done to Indian Conchology by the work of the several enthusiastic Surgeon-Naturalists on board the R.I.M.S. 'Investigator,' as a result of which the Indian Museum collections are very rich in deep-sea forms.

The history of the biological work of the 'Investigator' dates back to the year 1871 when the Council of the Asiatic Society of Bengal urged the Government of India to start investigations in the Indian seas similar to those of the 'Challenger' in the other great oceans. One of the chief arguments put forward by the Society was the hope that deep-sea investigations would probably discover many forms which were previously known to science only in the fossil state. The Government of India approved of the scheme put forward by the Asiatic Society, but the first Surgeon-Naturalist to the Marine Survey was not appointed till 1875, and though from this date researches on the shallow water and littoral fauna were carried out, it was not till 1884 that deep-sea work in its strict sense was first started. As this section deals with the Molluscs only, it is unnecessary to go into details of the work of the 'Investigator' here, but it may be mentioned that during 1880-1906 several valuable reports on the deep-sea Molluscs of the Indian waters, dredged by the 'Investigator', were prepared by such authorities as Nevill, Wood-Mason and Alcock, Smith, Sowerby and Goodrich. These reports were published in the *Journal of the Asiatic Society, Annals and Magazines of Natural History, London, Proceedings of the Malacological Society of London* and the *Transactions of the Linnean Society, London,* while the figures of the new and rare species were issued separately through the Indian Museum by the Directors of the Royal Indian Marine as *Illustrations of the Zoology of the R.I.M.S. 'Investigator'*. The entire collections, including the types of the different species, are

all preserved in the Indian Museum. It is also of interest to note that since the initiation by the Trustees of the Indian Museum of their own zoological publications, *viz.* the *Records* and the *Memoirs of the Indian Museum,* the results of all zoological work connected with the Indian Museum collections are published in these serials, and the *Illustrations of the Zoology of the R.I.M.S. 'Investigator'* are also now incorporated in the *Memoirs.* In passing one may also mention the collections of Molluscs, among those of other marine animals, made by the Bengal Fishery trawlers, S.T. 'Golden Crown' and some of the collections made by the collector of the Zoological Survey of India on board the S.T. 'William Carrick' in the Arabian Sea, which are also deposited in the Indian Museum.

Since Nevill's retirement in 1883 to 1918 the only work on the Mollusc collection of the Indian Museum, apart from the reports on the 'Investigator' collections mentioned above, consisted of reports, which were prepared by Fleure, Godwin-Austen, Germain and Preston, on some of the collections made by the officers of the Natural History Section of the Museum and later by the officers of the Zoological Survey. The three volumes in the 'Fauna of British India' series, one on freshwater forms by Preston and two on land shells by Gude, issued during 1914-1921, which were partly based on the collections of the Indian Museum, may also be mentioned here.

Another very important source from which rich collections were received in the Indian Museum, was the private enterprise of two of the officers of the Museum, *viz.* Dr. John Anderson and Dr. N. Annandale. The former of the two undertook at his own expense an expedition to the Mergui Archipelago and brought back a very rich collection of littoral and insular forms from that area. The Molluscs of this expedition were named by the famous authority on Molluscs, Dr. E. von Martens of the Berlin Museum; a report on the collection was published in the *Journal of the Linnean Society of London* for 1888, and all the named collections were presented to the Indian Museum. The late Dr. Annandale similarly during several periods of leave investigated the fauna of freshwater lakes in different parts of Asia. His work extended from the Lake of Tiberias in Palestine on the one hand, to Lake Biwa in Japan on the other. He brought back large collections of freshwater Molluscs and presented them to the Indian Museum. A number of these collections were made since the inauguration of the Zoological Survey and the greater part of this material was worked out by the officers of the department in Calcutta.

Valuable collections have also been received from officers of sister Surveys like the Topographical Survey, the Geological Survey and some members of the Indian Forest Service and Indian Civil Service, who collected specimens during their tours in outlying places and presented these to the Indian Museum.

Before closing this survey of the sources of the collections in the Indian Museum it is necessary to mention the various military and political expeditions on which zoological collections were obtained for the Indian Museum, and as a result of which this

institution possesses collections from such widely separated areas as Persia in the north-west to the province of Yunnan in China in the extreme east. The various expeditions, to mention only the names, were: Persian Boundary Commission (1870-72), Afghan Delimitation Commission (1885), Seistan Arbitration Commission (1903-05), Pamir Boundary Commission (1896), Second Yarkand Mission (1873-74), several private donations from the members of the Dafla Expedition (1874-75) and the Military Expedition to Lhassa (1903-04), the Abor Expedition (1911-12) and the two expeditions which passed from Burma to Western China in 1866 and 1875, and in both of which Dr. J. Anderson of the Indian Museum took a prominent part as a medical man and a naturalist.

On my appointment in 1920 the first consideration was to re-arrange the collections and to have these properly stored in boxes in place of the old pill and match boxes in which the specimens had been stored. At the same time it was necessary to fill up the gaps in the collections, and in the conchological and malacological literature in the library. Since my appointment the work of this section of the department has, as far as possible, been brought up to date, while besides large additions in the library, I have personally got together a very extensive collection of rare old monographs, reprints and separates for supplementing the rich collections now available in the departmental library.

The work on Indian Molluscs since my appointment has consisted in preparing and publishing fully illustrated monographs on different families—mainly of freshwater Molluscs, but land, marine and estuarine Molluscs have not been entirely neglected. Of the various monographs published, attention may be drawn to the anatomical and systematic account of some Indian Viviparidae by Col. R. B. S. Sewell and the late Dr. N. Annandale, Dr. H. Srinivasa Rao and myself, anatomical account of the Indian Planorbids by Dr. H. Srinivasa Rao, a detailed descriptive catalogue of the Planorbidae in the Indian Museum by Dr. L. Germain of the Paris Museum, and anatomical, systematic and zoogeographical monographs on Unionidae, Cyrenidae, Ampullaridae and Viviparidae by myself. In addition to these special reports on collections made in different parts of the country have also been published. The collections of the Indian Museum to-day are not only very extensive but are fairly representative of nearly all parts of the Indian Empire.

Without going into details it will probably be enough to indicate the lines along which the work is now being carried on. As long ago as the early fifties of the last century it was recognised that for a proper understanding of the relationships of the different Molluscs it was necessary to study not only the shells but the soft parts of the animals as well. Unfortunately, however, the study of the anatomy of these animals, except in some cases of the radulae, does not appeal to most Conchologists, and it has invariably been left for specialists who deal only with the soft parts. The results attained, by correlating researches on the soft parts with those on the shells of Indian forms, have fully justified the view that work on shells alone is in most cases very misleading. Further, in connection with the systematic studies on the Molluscs

of India, it has been found necessary to study their plasticity, variation in reference to different habitats and geographical distribution, all of which are of very great importance in connection with the systematic and faunistic work, which is one of the primary duties of the Zoological Survey of India. For a proper understanding of the relationships of the various recent forms it has also been found necessary to study the fossil remains from different parts of India and other countries and to correlate the results with those obtained from a study of the living forms. A research on which I have recently been engaged is the systematic revision of the Asiatic species of the freshwater bivalve Molluscs of the genus *Corbicula*. Our knowledge of the different species of this genus was in a very confused state, and it was found necessary not only to study very large collections from all areas but also to examine the old collections containing the 'types' in various Natural History Museums in different countries of Europe. Fortunately through the co-operation of the authorities of these Museums it was found possible to get almost all the collections for study in Calcutta, and the results of the work have fully justified the necessity of a careful revision of this genus. Similar studies are being carried out on other genera of freshwater and marine bivalves, and in many cases the fossil species have to be studied equally with the recent forms. In connection with the work on the Indian freshwater mussels or the Unionids, this is of particular interest, as the distribution of recent and fossil forms of this family is often of great help in determining the changes in the courses of the different river-systems during the past geological ages.

In connection with the revision of the different families of marine Lamellibranchs, through the generosity of Professor Max Weber of Holland, the entire unnamed collection of the Lamellibranchs obtained by the 'Siboga' from the seas round the Dutch East-Indies has been sent to me for identification and study. This work, it is hoped, will enable one not only to settle several difficult questions of taxonomy and distribution, but also, to some extent, determine the interchange which has taken place between the forms found in the Indian and the Pacific Oceans respectively.

The land and marine Gastropods of India are not being ignored, but naturally these forms have not so far been studied with the same thoroughness as the freshwater and estuarine types mentioned above.

In connection with the studies on Molluscs it has also been necessary to get a thorough acquaintance with the various sources for determining the exact dates of issue and publication of the various old monographs and periodicals and settling the very puzzling questions of priority in reference to the names of different genera and species.

As a further extension of my work on the distribution of Molluscs I have also made a special study of Zoogeography and Animal Distribution in particular reference to the Indian Fauna.

Molluscs in the form of dry shells from all parts of India will be gratefully received for the collection of the Zoological Survey

of India in the Indian Museum, while to those who are prepared to help a little further, we shall be glad to send instructions, as well as materials for collecting and preserving the animals in addition to the shells; such anatomical material, it need hardly be reiterated, is of far greater value than the dry shells alone. The areas from which collections will be particularly welcome are, the Northern districts of the Bombay Presidency, including Gujarat and Kathiawar, Western Ghats below Goa, Mysore, inland districts of the Madras Presidency near the West Coast, Central India, Assam, Burma and Kashmir, including Gilgit and Western Himalayas. Named duplicates will, if desired, be returned to the collectors from the collections presented by them.

THE BOMBAY NATURAL HISTORY SOCIETY'S INVESTIGATION INTO THE COMPOSITION OF SALT-LICKS

EARTH-EATING AND SALT-LICKING IN INDIA

BY

J. F. CAIUS, S.J., F.L.S.,

AND

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PART II

(*Continued from page 676 of Volume XXXIII*).

ANALYSES IV–VII.

IV. COMMON EARTH.

SERIAL NO. 4.

LOCALITY—Nalonwalag, Chandi Range, Lansdowne Forest Division, U.P.; 900 ft.

PROCURED BY—R. C. Singh, Forest Ranger.

SENT BY—Mr. F. W. Champion, I.F.S.

Grey lumps of clay with organic debris, mostly rootlets. Powder soft.

Clay	56·05	per cent.
Sand	34·83	,,
Organic debris	0·22	,,
Humus	3·87	,,
Moisture	2·01	,,
Fine Earth (20 mesh sieve)	98·03	,,
Insoluble in nitric acid	84·330	,,
Soda (Na_2O)	0·201	,,
Potash (K_2O)	3·664	,,
Magnesia (MgO)	0·452	,,
Lime (CaO)	0·245	,,
Alumina (Al_2O_3)	2·793	,,
Silica (SiO_2) soluble	0·056	,,
Sulphur (SO_3)	0·032	,,
Phosphorus (P_2O_5)	0·508	,,
Manganese (Mn)	0·036	,,
Ferric oxide (Fe_2O_3)	2·145	,,
Moisture and organic matter	4·280	,,

Remarks:—1. The soil contains a little over 2 per cent. water-soluble organic matter.

2. The earth was taken from an area which adjoins salt-lick No. 5, but is not visited by animals.

V. Soil from Salt-Lick (Nalki Salt Lick).

Serial No. 5.

Locality—Nalonwalag, Chandi Range, Lansdowne Forest Division, U. P. 900 ft.

Procured by—R. C. Singh, Forest Ranger.

Sent by—Mr. F. W. Champion.

Yellowish grey lumps of clay with organic debris. Powder soft.

Clay	87·47	per cent.
Sand	1·50	,,
Organic debris	0·04	,,
Moisture	3·71	,,
Fine Earth (20 mesh sieve)	96·89	,,
Insoluble in nitric acid	74 640	,,
Potash (K_2O)	5·812	,,
Magnesia (MgO)	0·999	,,
Lime (CaO)	2·526	,,
Alumina (Al_2O_3)	4·284	,,
Silica soluble (SiO_2)	1·600	,,
Sulphur (SO_3)	0·135	,,
Phosphorus (P_2O_5)	0·164	,,
Chlorine (Cl)	0·120	,,
Manganese (Mn)	0·072	,,
Ferric oxide (Fe_2O_3)	4·000	,,
Moisture and organic matter	2·500	,,

Remarks :—1. The soil contains traces of sodium and carbon dioxide ; also 4 per cent. water-soluble organic and inorganic matter.

2. The lick is frequented by wild elephants, tigers, deer, cows and oxen.

VI. Earth for Human Consumption.

Serial No. 6.

Locality—Shampur 8, Chandi Range; Lansdowne Forest Division, Garhwal; 325 feet.

Procured by—R. C. Singh, Forest Ranger.

Sent by—Mr. F. W. Champion.

Drab lumps of clay with a few rootlets. Powder soft.

Clay	77·71	per cent.
Sand	10·33	,,
Organic debris	0·09	,,
Humus	5·53	,,
Moisture	3·29	,,
Fine Earth (20 mesh sieve)	96·71	per cent.
Insoluble in nitric acid	78·500	,,
Potash (K_2O)	3·789	,,
Magnesia (MgO)	0·594	,,
Lime (CaO)	0·472	,,
Alumina (Al_2O_3)	6·461	,,
Silicia (SiO_2) soluble	0·015	,,
Sulphur (SO_3)	0·092	,,
Phosphorus (P_2O_5)	0·814	,,
Manganese (Mn)	0·003	,,
Ferric oxide (Fe_2O_3)	3·002	,,
Moisture and organic matter	4·000	,,

Remarks :—1. The soil contains traces of sodium.

2. This earth is eaten by women at the time of pregnancy.

VII. Soil from Salt-Lick.

Serial No. 7a.

Locality—Bellatur, Kollegal Taluka, Mysore.

Obtained and sent by—Mr. R. C. Morris, Honnametti Estate, Attikan P.O., *via* Mysore.

Gritty, light buff, coarsely granular earth ; finer portion soapy.

Minerals (mostly quartz)	36·62	per cent.
Clay	8·39	,,
Sand	41·20	,,
Organic debris	1·23	,,
Moisture	4·48	,,
Fine Earth (20 mesh sieve)	58·900	,,
Insoluble in nitric acid	42·680	,,
Soda (Na_2O)	0·202	,,
Potash (K_2O)	6·203	,,
Magnesia (MgO)	0·028	,,
Lime (CaO)	1·480	,,
Alumina (Al_2O_3)	3·120	,,
Silica (SiO_2) soluble	0·450	,,
Sulphur (SO_3)	0·125	,,
Chlorine (Cl)	1·380	,,
Ferric oxide (Fe_2O_3)	1·564	,,
Moisture and organic matter	1·670	,,

Remarks :—1. The soil contain traces of phosphorus and manganese.
2. The lick is frequented by cattle.

REVIEWS.

'THE FIELD-BOOK OF A JUNGLE-WALLAH', BEING A DESCRIPTION OF SHORE, RIVER, AND FOREST LIFE IN SARAWAK.—By Charles Hose, HON. D. SC. (Cantab), Author of *The Pagan Tribes of Borneo*, etc., with Frontispiece in colour, and 25 plates in Black and White, 216 pages. Published by H. F. & G. Witherby & Co., London. 1929.

The majority of the members of the Bombay Natural Society have no personal knowledge of Sarawak, but here is a book which will introduce them to the tropical forests of that country and provide them with a wealth of information concerning its animals and its birds; its trees and its insects; its flowers and its fishes; its minerals and its poisons; and all this in a most interesting manner.

The reader will journey in vivid imagination with the author who, with the experience and trained observation of many years (he entered the Sarawak Service in 1884), tells him of all he sees, or can see. For it is not all of us who have the eyes to see unaided, as that faculty comes only to those who have real interest in Nature, and the life so well expressed by the appellation Mr. Hose applies to himself of 'Jungle-Wallah.'

The forests of Borneo are more tropical than those of most parts of India, but we read and learn of much that is familiar to us, and that always lends added interest to a subject.

The walk along the Bornean shore with the casuarinas and the screw pines; the bare cliffs and the amber-coloured waterfalls; for scenery, introduces us to turtles and sea-eagles, prawns and pirates, and to something more familiar to us, viz., the green Bee-eater. We learn that this small bird, with the seemingly wholly unsuitable beak and feet has the surprising habit of nesting like a Kingfisher by making holes in the ground. Then we come across the Pangolin, a species also known to us in India, and a Honey-bear which is a stranger. Later on, we learn all about that curious fish, known from Africa to New Guinea as 'Mud-skippers' or 'Jumping-Johnnies', which are fast becoming land animals. Further on, we see the strange and beautiful fish captured by the native fishermen in a drag net. Some of these are similar to those of the seas which lap the shores of India; for instance, the *Buntalor* Balloon fish which, when inflated, resembles a gigantic horse-chestnut. Finally we see the nest of the Megapode, or Mound-building bird, and learn all about it and the many enemies it has; so it is fortunate that it is usually only found in the forests near the shores of uninhabited islands.

The spiral maze-trap—the *Kilong*—used at the mouth of the Baram river, is an ingenious and labour-saving contrivance,—in fact it is fishing made as easy as it is possible to imagine. Here we are 1,000 miles from China, the nearest land to the north, and during the

north-east monsoon can see immigrant birds in large numbers. Here also are fine wild water buffaloes with large horns, similar to the wild buffalo of India and Burma, which have been domesticated and trained to various uses among others as mounts for the District Police!

We learn that there are three species of wild pig and that here, as in India and other countries, the gallant boar fears neither beast nor man. Travelling up the river to Baram Fort, we meet all those biting and stinging insects with which we are familiar, and many others besides. Higher up the river we are introduced to the untouched primeval forest the abode of the real 'Dayak' and the pagan tribes who have communal houses three hundred yards long and containing perhaps a thousand souls.

Journeying on for a hundred miles and more, we take to canoes and ascend rapid streams where the natives 'fish' with the root of a plant which stupefies everything in the water, a practice not strange to the native of India. Crocodiles are large and numerous, and captured by means of the chicken and cross bar arrangement as in other parts of the East.

Among birds we meet the Indian Darter, Herons and Ibises; while, further on, are the wild cattle of Borneo, the Banting, the same animal as the *tsaing* of Burma. Of butterflies little mention is made, but two of the most beautiful are noticed, one of them five inches across the wings. Of the deer tribe are the Sambur, the Barking deer, and the Mouse deer; and we meet hosts of birds and insects peculiar to the Bornean forests and their phosphorescent nights.

If you will go with the author on 'Short-Leave Holiday' and to 'a Mountain Treasure-House', you will have a most absorbing time; for these chapters are packed with interesting things about birds, animals, and plants; and you will hear about several mammals named after Mr. Hose, their original discoverer.

The 'Wealth of the Jungle' will tell you all about Cutch, Antimony, Sago, Gutta-percha, and Camphor; also of Rubber and Pepper and Rice: and of this last the means by which the toper of strong drink can literally take it lying down and in as large or small quantities as pleases him. Here you will also read of the iodized salt which probably anticipated by an uncounted period of time the lately 'discovered' treatment of goitre; an illustration of the saying that, 'there is nothing new under the sun'.

The closing chapter of this very interesting book treats of the minerals and poisons of that country which is so rich in many things. There is the Datura which we know of and the Upas tree and other poisons which are strange to us. There is a shrub the product of which is, to man, only a partial and cumulative poison. It induces a feeling of numbness about the tongue and soft palate, and ultimately speech is affected. As Mr. Hose remarks in regard to it: 'In view of the increasing spread of democracy, it is possible that up to now its value has been under-estimated.'

The illustrations in the body of the work are good, and clear, and the index a full one, in which, however, the word 'goitre' is not to be found; and that is the sum of the adverse criticism there is to offer!

With a final look at the excellent photograph at page 66 which illustrates a 'Typical Sarawak Jungle Scene', the volume under review is, for the present, regretfully closed.

R.B.

TROUT FISHING FROM ALL ANGLES.—By Eric Taverner, with a chapter on Trout Scales by G. Herbert Nall, M. A., F. R. M. S., and the Legal Aspect of Fishing by Alban Bacon, Barrister-at-Law, 448 pages, with 250 Illustrations. Seely Service and Co., Ltd., London, S. 21.

This book is one of the Lonsdale Library series, and it is hardly necessary to say that, sponsored as it is by one of England's leading sportsmen, it is the last word in modern angling methods. Many years have elapsed since the fishing volumes of the Badminton Library were published, and in that time great changes have taken place as a glance at the text and illustrations of the earlier volumes will show. The present book, with its exhaustive survey of modern methods of trout fishing, is a worthy successor to the Badminton volumes and though it is intended primarily for the beginner, there can be but few anglers who will not read it with both interest and advantage. The first two chapters are devoted to a review of early angling literature and it will be news to most that as many as twelve artificial flies were in use upwards of 500 years ago, most of which were definitely copied from the natural insect and can be identified to-day. It is also of interest to note that one of the most valuable early publications was a treatise in 1600 by a namesake of the present author. The succeeding chapters on the life history of the trout are well written, but it is to be regretted that more information is not available as to the migratory tendency of the rainbow, a subject of the greatest interest especially to those responsible for the fisheries in India and Ceylon. The size to which trout attain is given as $3\frac{1}{2}''$ to $5''$ the first year and $5''$ to $8''$ the second; this of course refers to fish under natural conditions; in a hatchery with abundant food throughout the year, they will greatly exceed these limits. Mention is made of crayfish forming part of the trout's food supply under certain conditions; in the Nilgiris experience shows that the fish feed chiefly on small fresh-water crabs with which the streams abound, and as a result, seldom rise to a fly after attaining a weight of $1\frac{1}{2}$lbs. We agree with the author that the theory of colour-blindness in trout has little to support it and much practical observation to discredit it, but experience with the white moth makes us somewhat doubtful as to extent of the powers of nocto-vision claimed for them. There is an interesting paper on the nocturnal behaviour of fish as observed in the London Aquarium, published in Zoological Society's Proceedings for August, 1929. The plate on p. 62 illustrating a fish's cone of vision deserves careful study by the novice, as success in fishing depends so largely on the angler remaining unseen. Chapters V and VI are devoted to tackle; the author favours the split cane rod which is no doubt correct for Home conditions, but in India the green heart will be found more lasting as well as considerably cheaper. The

author's careful consideration of varnish, rings, reel and tackle deserve the closest attention by the beginner. In the chapter on casting the importance of two-handed control of the line and of 'shooting' is emphasized; the method is so easy to learn that it is surprising that it has not been more generally adopted. The various casts are well illustrated by diagrams and will repay careful study. The chapters on entomology, trout flies, etc., make interesting reading, but most anglers will prefer to skip these for the moment and pass on to the 'Practice' of angling which, with its admirable photographs, recalls the Home waters so well known to many anglers in India. The author holds an even balance between the wet and the dry fly and the sections of Chapter XVI dealing with the former afford most instructive reading to the Indian angler who seldom has an opportunity of using the dry fly. In the Nilgiris, practically all fishing is done with a well sunk fly and from the direction of the wind casting can seldom be up-stream. Anglers who live in out-of-the-way parts of India and have to re-condition or repair their rods themselves, will find much helpful instruction in the chapters on knots and splices. As regards hooks, there can be no question of the superiority of the eyed type for India; hooks to gut are most liable to draw if exposed to heat. The chapter on rise-forms deals with the subject at greater length than we have come across elsewhere; the author's conclusions are sound and instructive, but, like the subsequent chapter on trout scales, more for the advanced fisherman than for the beginner. Chapters XX and XXI deal with fly dressing materials and methods; they are illustrated by a coloured plate and numerous diagrams. It is unfortunate that so few anglers nowadays learn to tie their flies; with a little practice, it is by no means difficult and the satisfaction of taking a good fish on a home-made fly has to be experienced to be realized. The remaining chapters on loch fishing, spinning and worming are all instructive, while those on the legal aspect of fishing and on fishery management are of importance to anglers in India who intend to take a fishing at Home or who have control of fisheries in this country. A list of the various close seasons in different part of Great Britain would have been of special interest to any one returning Home on leave. Mr. Eric Taverner is to be congratulated on having compiled such a practical and instructive work which must long remain a standard on modern methods of angling. The book should be in every fisherman's library.

E. P. A.

3. A GUIDE TO THE ORCHIDS OF SIKKIM.—By P. Bruhl. Pp. xvi and 207. Calcutta and Simla. Thacker, Spink & Co. 1926. Rs. 5.

This is a guide to a group of plants which, while exhibiting in great variety some of the most beautiful flowers in the plant kingdom, are not only of absorbing interest to the amateur plant collector and the horticulturist, but are also objects of fascinating study

to serious students of botany. The little book intended to enable its possessor to identify orchids with the minimum equipment in training and apparatus. The diagnostic characters of genera and species have been so chosen that they can be easily made out by the naked eye, except in a very few cases, where the use of a simple pocket lens and a razor or a sharp knife are the only other tools required.

The book, we are told, is primarily meant for the non-botanists, wherefore the minimum number of easily-learnt technical terms have been introduced. The 95 genera and 455 species (only 453 are mentioned in the preface) are arranged in the form of what is known as the dichotomous plan, exemplified in the preface by working through a concrete case.

Although dealing primarily with species from between the Terai and the northern frontier of independent Sikkim, including the Chumbi valley—a region particularly rich in Orchid flora—it will also be found useful in other parts of India, chiefly the Himalayas, where most of the species dealt with here are also of general occurrence.

The reader is assured that the key has been tested over and over again 'in the field and the forest, in the green house and the verandah,' and the book is of such size that it can easily be carried in one's pocket, a feature which will greatly add to its usefulness. Orchid lovers will particularly feel grateful to the author and the publishers for the publication of this guide.

N. K. T.

4. WHAT BOTANY REALLY MEANS—Twelve plain Chapters on the Modern Study of Plants. By James Small, D.SC., F.L.S.; 1928: London George Allen and Unwin, Ltd., Pp. 200. 5 Shillings net.

The true appreciation of the fundamental importance of plants as being responsible not only for the maintenance and progress of civilization but of its very existence is not usually recognized by the generality of mankind. This is not due always to their indifference but also to the fact that most books on botany—and sometimes even the so-called popular ones—are written in a language which fails to appeal to them and is positively frightening by reason of the manner in which the subject matter is presented and the injudicious use of 'big words' (as the author of the present book calls the technical terms). The result is that an impression has gradually grown up and gone abroad that the study of plants is the monopoly of the selected few and is therefore of very restricted use and application. The resulting ignorance has not only prejudicially affected the course of civilization but its consequences have often been appalling.

Fortunately of late, there has been a tendency among botanists to realize the necessity of presenting in a popular way the fundamental facts of plant life in simple and intelligible language. To such books the present work is a welcome addition. It 'is an

attempt', as the author puts it, 'to make plain something of what we know about plants and plant life.'

The subject-matter of the book contained in twelve chapters is based largely on half-hour talks broadcast to schools by the author. The conversational form of the text has been retained on purpose and is sure to appeal to the class of readers for whom it was intended and whom the author now seeks to approach. In the 200 pages the author has endeavoured to present the various phases of plant life, with particular emphasis on the economic aspects, in language which is simple and in a manner which makes the book read like a romance. Throughout the book the author, discriminatingly and with full effect, makes use of many facts of everyday experience in order to drive home some obscure or important idea or conception otherwise difficult to express in a popular language.

The central idea with which the author starts and which runs throughout the book and is again and again referred to and elaborated is that of an 'Effervescent World'. According to this idea, life is likened to a lemonade bottle consisting fundamentally in the bringing together of carbon dioxide and water, followed by a separation of the two. Between these two events lies spread the whole pageant of life whether manifested by the simplest types of living organisms or by the most advanced. The lemonade factory where the first change is effected is the Green Leaf. The author clearly describes how this factory works, and how later it transforms the simple substances absorbed from the soil into products which are indispensable alike for the continued existence of life as for the progress of the world.

While the whole book reads like a fairy tale, the chapter dealing with the the adventures of the running sap has a special charm of its own, and grips the attention of the reader, while he follows, with pathos, the changing fortunes of a drop of water (personified into a human being) from the time it descends to earth as rain till it escapes out again as water vapour from the leaf.

The book should be of great help to teachers of Nature Study and to such others as wish to acquaint themselves with the fundamental facts of plant life without taking a course in Botany. The author lays claim to using not more than three technical terms. The class of readers whom he seems to have had in mind is manifestly different from those in India, for it will be difficult for many lay people here to comprehend the meaning of many more words which are to be found in the text. At the same time it must be admitted that the number of such technical words has been reduced to a minimum.

N. K. T.

MIGRATION OF WILDFOWL

THE SOCIETY'S RINGING SCHEME

Since the publication of the last lists in Vol. XXXIII, No. 3 and No. 4 of the *Journal*, 719, the following recoveries of ringed birds have been reported to us, the first two by the Central Bureau of Regional Survey, and the last named by the Commissariat of Agriculture, Moscow.

Place of ringing	No.	Date	Species	Ringed by	Date of recovery	Locality
Manchar lake, Larkana Dist. Sind.	2783	Jan. 26, 1929	Mallard *A. platyryncha.*	R.B. Maclachan.	April, 25, 1929.	Ishimsk, District Ural (*circa* 56°0′ N. lat. 66° O5E. long).
Karachi Sind.	2875	Dec. 12, 1928	Do.	C. Chatterji.	August, 1929.	Omsk Siberia (*circa* 55°0′ N. lat. 75°0′ E. long.).
Sujawal, Karachi District Sind.	1810	Feb. 9, 1929	Pintail *P. acuta.*	Meherally Shah Bukhari.	May 15, 1929.	Samarovo, Tobolsk Dist., Siberia (60° N. lat. 70° E. long

The Central Bureau of Regional Survey, Moscow, which is collecting data in connection with the ringing of birds in Soviet Russia, would be glad to receive reports of recoveries of birds ringed by them in Russia and Siberia. During the summer of 1929 this scientific organization ringed a great quantity of ducks in the Barabinsk Steppe, Siberia (*circa* 53°–50′ N. lat.; 75°-85′ E. long.).

The birds ringed belonged chiefly to the following species :—

Pintail (*Dafila acuta*).
Common Teal (*Nettion creca*).
Shoveller (*Spatula clypeata*).

The Russian rings bear the marks :—
"5ЮH. MOSKWA"

Recoveries should be reported to the Director, Central Bureau of Regional Survey, Moscow, or to the Honorary Secretary of this Society.

EDITORS.

BOMBAY NATURAL HISTORY SOCIETY,
6, APOLLO STREET,
October 15, 1929.

THE TOXICITY OF THE VENOMS OF INDIAN SCORPIONS.

PROGRESS OF THE SOCIETY'S INVESTIGATION.

Scorpion Venom.

	Number of Scorpions	Weight of dry Venom in milligrams
Butheolus bicolor ...	1	0·0
,, *melanurus* ...	5	0·0
Buthus australis ...	1	0·9
,, *pachyurus* ...	57	25·5
,, *rugiscutis* ...	12	2·6
,, *lamulus* ...	357	786·5
Pulamnaeous bengalensis ...	2	9·7
,, *fulvipes* ...	53	174·7
,, *gravimanus* ...	4	14 6
,, *liurus* ...	19	12·5
,, *longimanus* ...	5	18·5
,, *phipsoni* ...	10	48·6
,, *swammerdami* ...	40	559·4
,, *xanthopus* ...	4	14·5
Scorpiops asthenurus ...	5	5·6
,, *montanus* ...	7	3·6
Isometrus europaeus (vesicles) ...	10	7·9

PHARMACOLOGICAL LABORATORY,
PAREL, BOMBAY.
October 14, 1929.

J. F. CAIUS.

MISCELLANEOUS NOTES

I.—STRANGE BEHAVIOUR OF A TIGRESS.

Reading Mr. Morris's further reference to the sense of smell in the Indian *Felidae* in the current issue of the Journal, Vol. XXXIII, 3, the following experience may be of interest and worth recording in the Journal:—

I was touring in the C.P. last January with a well-known sportsman Forest Officer, when we had news late one afternoon of a kill.

We packed up and made for the spot, getting there about 4 p.m. and, having tied up a machan in haste without any cover, got into it, a most uncomfortable one, at 4.45. Shortly after, a barking-deer warned us of the tigress moving, and at 5.45, exactly an hour of waiting, we saw her come down a dry nallah on our right, only about 30′ from us and in full view the whole time. She did not appear the least bit suspicious and it was not until she came to what we estimated was the direct line of wind from us and the kill to her, that she stopped. It was most interesting to see her sniffing the wind like a spaniel which wind, we imagined, was from her kill. After standing here for a couple of minutes, she moved further down the main nallah up to its junction with the smaller nallah, into which the kill had been dragged and lay. Previous to getting up into the machan, I had walked down the smaller nallah to the junction to see a good pug impression of my likely trophy, unknown to my host of course. It was here that I had my object lesson, as, when the tigress came to this point and started moving towards her kill, she stopped, half crouched, with her nose to the earth, and after uttering a low growl turned and walked off down the main nallah. This was behind us and over my right shoulder, or I could have killed her when she made her first appearance. That she had smelt me from my foot impression there could be no doubt. She turned up again at 8.10 p.m. when she made loud snarling sounds under our machan and again moved off. We decided to cheek at 9.45, and blew two long blasts on a trumpeter's whistle for the elephant and the ladder men. Hardly had this been done when we spotted her in a patch of bright moon-light looking in our direction, head on, still on the right. It was most trying, we could hear the men approaching with a light, and she also made a few steps in the direction of the kill. When the men were 40′ of us we saw her move off at a walk up stream. No sooner had the men arrived than they were told in a whisper to return; and, hardly had they done so, when she again appeared, this time from in front of us.

It was a most interesting experience, as in the first instance she showed such great caution, and latterly made the bold march up to her kill hardly before the men were out of hearing.

My host, who has shot 50 odd tigers himself and been in at the death of nearly three times this number, could make nothing of the experience. It is worth mentioning that in between the visits she paid us, we heard her calling at intervals, what is commonly believed to be the mate call. She was a young animal and had not had cubs; she taped 8 foot.

URNA ESTATE, A. MACDONALD.
MAROWRAH P.O.,
B. & N.W.RY.,
August 1, 1929.

II.—THE CARCAL IN IRAQ.

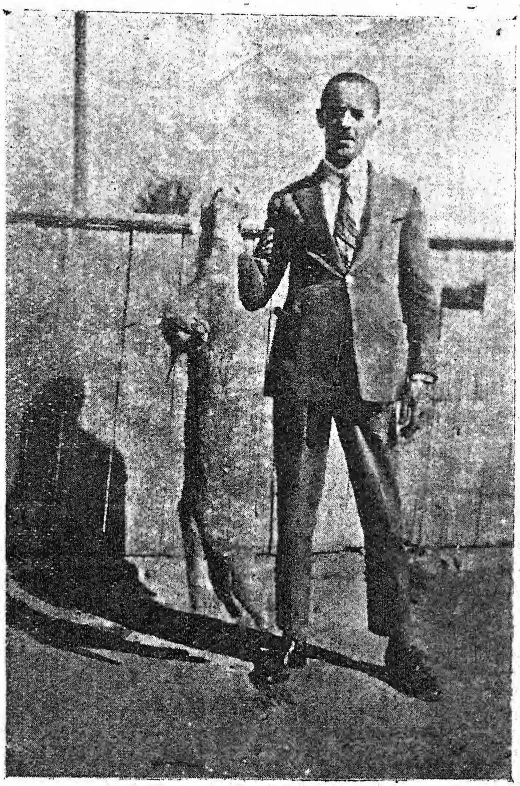
(*With a photo*).

Blandford gives Mesopotamia as the distribution of the Caracal, *Felis caracal.* Pitman in the *Survey of Iraq Fauna* records a possible occurrence. Tristram in the *Survey of Western Palestine* refers to it as the Red Lynx, mentions its scarcity in Palestine, and states that it has a wide distribution occurring through 'all Africa, Arabia, Persia and India'. Sterndale gives Africa, east to Western Asia and India. Protheroe gives S. Africa, Egypt, Arabia and India. Loftus has recorded a specimen from Dizful. One would expect, therefore, that the animal would be found within the confines of present political Iraq.

One possible source of confusion is the jungle cat, *Felis chaus,* possessed of large size, black ear-tufts, yellow tinge, and short tail; it has, however, pronounced markings. The caracal has no obvious markings and is usually of a brick-red colour. One must remember, however, that Buxton in his *Animal Life in Deserts* (p. 160) refers to a desert type from Asben in the South Central Sahara, described by Thomas as differing from all known caracals 'in its exceptionally pallid colouration and silvery ears'. A further source of confusion is of course the true Old World lynx, *Felis lynx* or *isabellina.* Points of difference are the occurrence of a defined ruff in the lynx and the relatively greater length of the tail in the caracal. Tail length to body length ratio in the lynx is about 1 : 4, whereas in the caracal it is at least 1 : 3. The lynx again is of a stolid build, the caracal smaller and of more delicate proportions. The lynx is grey or fawn and may have a suggestion of spotting, particularly in summer (Sterndale's *Mammalia of India,* p. 94). It is stated by Protheroe that the under-parts of the caracal also are slightly besprinkled with black and chestnut spots; the general tinge of the caracal, however, as mentioned above, is reddish. The lynx appears to be the more decidedly 'spotted' animal of the two.

The Arabs in Iraq certainly recognize several sorts of wild cat and various names are current. They seem to me, however, to be applied quite fortuitously and to have no particular classical application. What is '*gurta*' to one man is '*herreh*' to another and merely

a '*bizoon*' *or* '*saba*' to a third; '*washa*' is another common name for a 'big cat'. The descriptive abilities again hardly come up to the requirements of classification.



CARACAL SHOT NEAR RUTBA, MESOPOTAMIA, 1924.

An animal is described, however, from time to time which suggests the Caracal. I have seen no skins unfortunately and was very pleased to get hold of two photographs of an animal shot by Mr. Reid of the Nairn Transport Company near Rutba in 1924.

The animal has the flat face and pointed ears that one associates with the lynx or caracal. The tail is not 'bobby' and relatively too long for the lynx; there is no ruff, spots are missing and the animal lacks the stolidity of a lynx; it has the finer proportions suggestive of the caracal. A suspicion that this was a specimen of the latter animal was confirmed by the Bombay Natural History Society.

ROYAL COLLEGE OF MEDICINE, NORMAN L. CORKHILL.
BAGHDAD,
October 21, 1929.

III.—DISTRIBUTION AND COLOURATION OF THE LYNX (*LYNX LYNX*).

This morning, while looking for Ibex, I saw, what I take to have been four lynxes—one, an old animal and three cubs of about a year old. They were under observation with binoculars for over an hour at a range of 300-500 yards.

I am acquainted with the skins seen in the furrier's shops in Northern India and called Tibetan Lynx. These are a soft brownish grey turning to almost white on the under-parts. The old lynx which I saw this morning was a bright orange red—the colour almost of a tortoise-shell cat: whereas the cubs were a grey brown, though one of them showed signs of turning red. My *shikari* called them '*phiauku*' and said that they were plentiful hereabouts. He says that when he was with one of the Mammal Survey collectors here, about ten years ago, he saw seven of them together.

When first seen, the old one was lying down in the shade of a rock, whilst the cubs were playing about like kittens. However, they soon settled to sleep in some long grass and the family was finally disturbed by my tiffin cooly and made off—the kittens a long way in the rear of their parent. Since writing the above, I have seen another '*phiauku*'. It was also bright red.

KYELANG, LAHOUL,
KANGRA DISTRICT,
August 11, 1929.

D. G. LOWNDES,
Captain,
Royal Garhwal Rifles.

[Blanford gives the distribution of the Lynx as the 'Upper Indus Valley, Gilgit, Ladak, Tibet, etc.; also throughout Asia north of the Himalayas, and Europe north of the Alps. Lahoul, where Capt. Lowndes observed the animals he refers to, is a province which is formed mainly of the watersheds of the Chandra and Baga Rivers which rise in the great Baralacha Range of the Western Himalayas. This gives a more southerly record of their distribution of these animals, though Lydekker in his *Great and Small Game of India* mentions that Lynx cubs are occasionally taken by the natives of Spiti which, like Lahoul, is one of the provinces grouped about the Rotang and Baralacha Ranges. In Rowland Ward's *Records of Big Game* there is a record of a skin obtained by Col. A. E. Ward in the United Provinces—where exactly is not mentioned. In the Tibetan Lynx (*Lynx lynx isabellina*) the general colour is pale sandy grey or isabelline. The under-parts of the body are white. The animal is regarded as a pale coloured local race of the ordinary lynx of Northern Europe and Asia. This pale race occurs in the plateaux of Eastern and Western Tibet. In the neighbourhood of Gilgit, where there is a certain amount of forest, the lynxes assume a more rufous tinge and thus imperceptibly pass into the typical European form in which the colour may occasionally be a rusty red (Lydekker). Lahoul is described as a treeless country. Amidst the waste of rock, stone, snow, there are small patches of birch and

rhododendron and here and there stretches of hillside covered with blue pine.—EDS.]

IV.—THE HUNTING LEOPARD (*CYNÆLURUS JUBATUS*) IN THE CENTRAL PROVINCES.

I shot a Hunting Leopard on December 26, 1926, in the Harrai Jagir (Chhindwara district) very near the Narsinghpur border, at a place called Kodari, lying on the main Narsinghpur-Chhindwara Road. The skin and head were mounted for me by Messrs. Van Ingen & Var Ingen, Mysore, who pronounced it to be (*Cynælurus jubatus*). It is a splendid specimen.

Mr. C. F. Turner, C.I.E., I.C.S., Commissioner of this Division, suggests that I should report this to the Natural History Society for record, as he believes no wild hunting leopards have been known in these parts for the last 50 years.

NARSINGPUR, *July 12, 1929.* J. M. RICHARDSON, I.M.D.

[Writing of the Hunting Leopard, Dunbar Brander (*Wild Animals of Central India,* p. 273) states that the animal has now almost entirely disappeared from the Central Provinces without apparent reason. He only knew of three animals being procured in the last 20 years. Rumours of their existence in parts of Berar, the Seoni Plateau and Saugor still persist, and the writer believes that one or two may still be found. In Vol. XXVII, p. 397 of the Society's *Journal*, Brig. Genl. R. G. Burton gives several records of Hunting Leopards shot in the Berar District between the years 1890 and 1895. They appear to have been fairly common in that district about the period mentioned. On the same page, the late Col. L. L. Fenton records the distribution of the Hunting Leopard in Kathiawar. In Vol. XXVI, p. 1041, there is an account of its occurrence in the Mirzapur District, U.P. Little is known of the present distribution of this animal in India. It is said to be still fairly common in the Hyderabad State, but we have no authentic records. Further information from readers of this *Journal* would be welcome.—EDS.]

V.—MALAY BELIEFS AND LEGENDS ABOUT TIGERS AND WILD DOGS.

One evening, recently, a friend, who is a great Malay scholar asked me how many tiger cubs there were in a litter. On replying that to my belief, there were two or three, he proceeded to tell me a Malay legend regarding the number of cubs in a tigress's litter. The Malays maintain that a tigress gives birth to seven or eight cubs and explain the fact that only two or three are seen with the mother as follows :—When the cubs are a few weeks old, the tigress makes them lie in a row and commands them that on no account are

they to touch her tail. She then lies down and twitches her tail in front of them. Should a cub try to touch her tail, the irate mother kills it. The remainder are then tempted and, on disobeying the command, are killed until there are only two or three left.

Another belief with regard to the tiger is that the cubs do not suckle but that the mother squirts her milk on to leaves, etc., and the cubs lick the leaves.

Miscellaneous note No. 9 in Vol. XXXIII, No. i, on the Malayan Wild Dog (*Cuon rutilans*) prompts me to write giving a Malay superstition regarding that little hunter. The Wild Dog, the *sirgala* or *arjing kutar* as he is called by the Malays, is not uncommon in some parts of the north of the Malay Peninsula, but is extremely rare in the south. The Malays consider it unlucky to meet a pack, believing that disaster is inevitable within a year if the dogs give tongue without their being forestalled by those unfortunate enough to meet them. The Malays also believe that the urine of the *sirgala* causes blindness and that the dogs purposely urinate against trees and grass through which their prey is likely to pass.

SUNGEI PATANI,
June 18, 1929.

ALEXANDER CROSS.

[Stories of wild dogs ejecting a fluid or using urine to blind their quarry are current in many parts of India. One explanation put forward is that the myth may have arisen through the fact that when wounded and pursued, they will sometimes, through fear, lose control of their functions and so wet or defile their tails.—EDS.]

VI.—SEASON OF SHEDDING AND GROWTH OF ANTLERS IN THE SWAMP DEER (*RUCERVUS DUVAUCELLI*) IN ASSAM.

In Dunbar Brander's *Wild Animals of Central India,* p. 200, Lydekker's statement that Swamp Deer grow horns in March and April appears to be doubted. Whilst in Assam, last April, I saw stags with horns fully grown in velvet and in process of shedding the velvet.

CHERAT,
N.W.F.P.,
July 25, 1929.

D. MONCRIEFF WRIGHT,
Capt.

[Referring to Lydekker's statement in his book, Dunbar Brander writes: 'I am in no position to contradict this statement as regards Assam, but it is certainly not true with regard to the United Provinces and Central Provinces. The herds do not disperse in spring, and stags do not shed their antlers in April, and many small stags are still in horn at the end of the month. To find a stag in velvet in March presupposes that the horn was shed in February or even January.' Presumably this is what exactly happens in Assam.—EDS.]

VII.—ENCOUNTERS WITH ELEPHANTS ON THE BILLIGIRIRANGAN HILLS

SCENE: CAMP-NAMAGUNDI— BILLIGIRIRANGANS.

Event I—

A party of four were in camp: two men and two ladies. Soon after nightfall, a herd of elephants started trumpeting near camp, and shortly after this the herd entered the shola the camp was in from the western side, surrounded the camp on three sides, commenced to demonstrate, and things looked decidedly nasty. The Sholagas (jungle tribe, excellent trackers) feverishly made a ring of fires round the camp with all available firewood, and shots were fired. Every now and then an elephant would crash through the jungle with a shrill trumpet, to within a few yards of the ring of fires, to be met with shouts and yells and a volley of shots. It was a weird and wild scene; the glare of the fires round the camp lighting up the figures of the two sportsmen standing with guns at the ready (shot guns were being used) with loaded rifles at hand for any elephant that might break through the ring of fires, the two women standing behind trees, and the Sholagas running from fire to fire, waving fire-brands, banging kerosene tins, and yelling vociferously. There was not a tree in the vicinity that an elephant could not knock down with ease. Beyond the light shed by the fires was inky blackness, and from here issued terrifying roars, trumpets, and a medley of other sounds and crashes from the elephants. Every now and then the whole herd seemed to advance, and once or twice it looked as if they would charge over the camp *en bloc*. It was during one of these attacks that one of the women, in an extremity of fear, climbed a small tree which was little more than a sapling (even so how she managed it she could not say later) and the sapling bent over and deposited her gently into a small stream that flowed past the camp! It was a succession of advances and retreats, sometimes by the whole herd, at others by elephants singly, or in twos and threes. One tusker, bolder than the rest, very nearly broke through the ring, and the rifles were quickly seized, but he turned and went back into the darkness just in time. After fully three hours of this, the whole herd finally retreated, but could be heard venting their rage on trees in the vicinity : and then a series of trumpets and thuds gave one the impression that two tuskers were fighting, which turned out to be correct on the following morning: still later, the noise subsided, except for now and then low grumbling like the rumblings of a distant thunderstorm. There was, however, no sleep for the party in camp: there was a possibility of the elephants returning to the attack, which fortunately did not occur. The morning dawned on a scene of destruction for about 200 yards to the south, east and north of the camp where the jungle had been smashed up and trodden down by the elephants for several hours. Sholagas reported that the elephants were still within a half-mile of camp, and the two

men went out with their rifles, and watched a Homeric fight between two tuskers—a battle of the Giants. One was a bit smaller than its adversary, but had larger tusks, and distinctly had the advantage, and finally defeated its opponent, and could be seen chasing it through the jungle, away from the proximity of camp, followed by the rest of the herd. A broken piece of tusk was later picked up. Thus ended an extraordinary incident. It was supposed that the elephants found that the camp was on their path, and decided to try to oust the intruders, but it is possible that the two tuskers had already commenced their battle and were in no pleasant frame of mind, and became more infuriated when they discovered the camp pitched on the elephant path (unknowingly), and led them on to the attack. It is stated that African elephants have been known to do this, but, in connection with Indian elephants, a case such as this must be very rare.

The ladies decided that they had their fill of shikar experiences for the time being and were escorted back to the Estate by one of the men. On their way back they encountered a cow elephant with a calf which demonstrated at them, and seemed to be of two minds as to whether to charge down on them or not, luckily deciding not to.

Event II—

M. and his sister were out in camp some years ago; the latter had elected to remain in camp one morning, while the former went out for a stalk. A rogue elephant, described as the Dodsampagai Rogue, was known to be wandering somewhere in the vicinity. At 10 a.m., while M.'s sister was reading at the door of her tent, a wild shriek from the chokra made her start up, and she was horrified to see that a large tusker had stalked quietly into the camp: she then felt her Miniature ·22 Rifle thrust into her hand by the chokra from inside the tent; and heard his agonised whispers of 'Shoot, Missie, shoot!' Finding that she was not yielding to his entreaties in this respect, he skimmed up a tree alongside the tent in a marvellous fashion. All this time the tusker stood still taking everything in, but luckily decided not to attack. It turned and walked out of camp as slowly and quietly as it had come in, and made for the narrow strip of shola which was known to be its usual habitat. At midday M. and his trackers, while returning from the morning stalk, and passing this shola (incidentally giving it their wind) were startled by a short sharp trumpet and out charged the Dodsampagai Rogue. M. was carrying a ·500 Express Modified Cordite Rifle and had just time to fire at the charging rogue's head, which made it swerve and present his broad side. A second shot fired behind the shoulder was a lucky one, and got the elephant through, or in the region of the heart, and, rushing on for another 200 yards or so, he collapsed dead. Thus were avenged the deaths of Dod Toddy Mada and his son Jeddia, two Sholagas, who had walked right into the rogue on a misty monsoon day near the same spot a year before and were killed, and torn limb from limb.

Event III—

M., his wife and a friend were in camp, and had retired to bed. At midnight M. was woken up by his wife who said, 'I am sure there is an elephant in camp' (the same old camp).—'Rats!' was the unfeeling and sleepy reply, but hardly was this spoken when M.'s Irish Terrier, which was sleeping at the door of the hut, rushed out barking furiously and then was heard a shrill trumpet and crashing as an elephant careered out of camp with the dog after it. For a few moments pandemonium reigned, shouts and yells from the camp Sholagas and shots from M. and his friend helped to speed the uninvited and undesired departing intruder! It turned out that this elephant was one of a herd feeding near, and had wandered in the direction of the camp and found itself in it before it knew where it was!

Event IV—

M., his wife and the same friend decided to visit Bellagulla for bear. It got dark when the party were within a mile of camp, and M. stopped at a nulla to light a lantern, resting his ·375 Mauser Rifle he had been carrying against a rock. Absent-mindedly he picked up the lantern and the party moved on along the path, leaving the rifle behind! When within 200 yards of camp, shouts from Sholagas up trees warned them that the Bellagulla rogue had temporarily taken possession of camp; and to make matters worse, 'Peter' the Irish Terrier scented the elephant and, probably remembering how he chased an elephant out of camp on a previous occasion, rushed in and bayed the rogue! Followed a devil-of-a-to-do, and a nasty situation for the group, as it was pitch dark, and the rogue could be heard kicking up the dickens of a hooroosh, 'Peter' barking wildly, and the elephant trumpeting, but not retreating. Soon 'Peter' realized that he was up against a different proposition altogether, and raced back to M. and the others, followed, however, by the now infuriated tusker. Shots were fired into the air, and the Sholagas yelled and tried to light the grass, which however was too green to burn. Luckily the elephant turned aside when just short of the party and they got to camp without further trouble. Seizing his ·450 H.V. Rifle when they first heard the elephant, M. had not had occasion to think about the ·375 Mauser and it was not till camp had been reached that he remembered that it had been left behind in the nullah. It was decided to send for the rifle in the morning. This was done and, when they returned from the morning stalk, M.'s rifle, or what remained of it, was lying in front of the hut. It was literally smashed to smithereens. The woodwork was matchwood, and the barrel and breech and bolt were hopelessly damaged. The rogue had apparently gone along the path that the party had taken to camp, and, scenting human taint on the rifle in passing, had given vent to its rage by smashing it to pieces on the rocks. Not satisfied with this, proceeding further, the rogue had come on a cow, which M. had tied up for tiger, and kicked the wretched animal to death! M. and his friend vowed they would do the rogue

in at the earliest opportunity: this soon came, the rogue was marked down, and laid low—an enormous elephant, 10′ in height at the shoulder, with a large single 6′ tusk.

Event V—

M. was shikaring at Bailur, a good spot in the old days, and was one morning walking down a fireline with a Sholaga tracker. When round a corner ahead a call was heard, which, the Sholaga insisted, was a bear. Advancing forward rapidly, M. and the Sholaga came face to face with a tusker which immediately charged. The tracker lost his head and must have achieved well nigh a record for a half-mile sprint down the fireline with a heavy rifle on his shoulder, omitting in his hurry to pass it to M. Followed a few intensely exciting moments from bamboo clump to clump with the elephant in close pursuit. The elephant soon tired of this however and made off much to M.'s relief. What followed when the Sholaga returned jauntily carrying the rifle, having viewed the elephant's departure from a safe distance and congratulated M. on his escape, need not be recounted.

Event VI—

On a hot day some years ago, M. and his sister, companions in shikar, were resting on a patch of sheet rock on the bank of a stream waiting for the tiffin basket to come down from camp, when they saw a cow elephant and two small calves pass across their front on the opposite bank of the stream. The Sholaga tracker was very emphatic that the elephant could not cross to their side of the stream, the banks being very steep for two or three miles down. Thus reassured, they lay themselves down and slept, and so did the tracker. After they had been dozing for about an hour, a loud crack awoke them, and slowly turning his head, M. saw the cow and her two calves towering over them barely 30 feet away. Shades of unholy pachyderms! Of all the nasty situations this was the worst. M.'s sister pluckily did not move, but the Sholaga whispered incessantly, terrified with terror, 'Shoot, shoot!' and nearly gave them away. Luckily he had the sense not to get up, and was hidden from view of the elephants by a boulder. The rifles were unloaded (it was mid-day, very hot, the jungle burnt clean, and ordinarily there was little possibility of any game being seen till later); it would have been a fatal move at such close quarters to try and load them. After standing motionless, a calf on either side, the cow and her calves advanced and passed close to M., within a few paces, and slid down the steep bank into the stream passing below the sheet rock up the stream so close that the back of the nearest calf could have been touched with an outstretched rifle. They then climbed up the bank on the opposite side, and soon disappeared from view. The tracker was quietly crying with relief! On a previous occasion, when sent to the camp with a message in the moonlight, he had come face to face with an elephant and emitted, rooted to the spot, a series of the most ghastly shrieks imaginable. Luckily the elephant was not inclined

to do him any harm, although encountered at such close quarters, and, watching him for a minute or two, turned off into the jungle.

Event VII—

M. had wounded a boar in a valley covered with thick deciduous forest, and followed it up into a gully in which grew several large clumps of bamboo. Here the pig was found lying on its side at its last gasp, and was given a finishing shot. The results were startling: crashes to the left and right, and a tusker came into view on M.'s left front and a solitary bull bison on his right! Game paths running on either side converged and met behind bamboos to the front and on these paths the two huge animals rushed, and met! There was a terrible thud, preceded by a short trumpet from the elephant and followed by a bellow from the bison, and then a crash and a struggling in the bamboos, and the elephant appeared to the right moving rapidly off. Advancing cautiously, M. and his men saw the bull bison, a magnificent specimen, lying against a clump of bamboos, breathing heavily, and with a horrible wound in its near side, undoubtedly caused by the elephant's off tusk. The tusk had penetrated one of the bull's lungs, and a hissing noise sounded from the wound as the poor brute breathed. A bullet in a vital spot soon put it out of its distress: and thus closed a very extraordinary occurrence, one which M. can be said to have been in a way responsible for, as it was his shot, magnified in the gully they were in, that roused the tusker and the bull, and in their flight the elephant, alarmed and angry, saw the bison approaching along the other path and deliberately rammed the old bull, probably attributing to it the cause of the disturbance. The elephant later met M.'s tiffin cooly, who said he had just escaped with his life up a tree as the elephant had chased him: and to prove this he showed M. the contents of the tiffin basket—a mass of broken crockery and glass mixed with food, and no beer to drink!

Event VIII—

M., his wife and children were motoring up the ghat road one evening, returning from a trip to the Nilgiris, when round a corner they came on a herd of elephants. M. jumped out with his rifle, while his wife reversed back and out of sight. M. stood watching the elephants move slowly off the road into the jungle below, when round the corner the car came buzzing again, another elephant had apparently made its presence known behind them!! In the meantime the last of the herd had moved into the jungle, and the car rushed past them, much to their consternation and surprise. On another occasion, motoring up the road at night, an elephant trumpeted just off the road as the car passed it, and was heard to rush swiftly through the grass, whether after the car or not it was difficult to tell for certain. Elephants were all over the place; M. and his wife expected to meet one round every corner, and suddenly, when within half a mile of the first Estate, the expected happened. An elephant stood facing the headlights of the car standing on the roadside, so close that their only chance lay in an attempt to rush past it, and this they did; M.'s wife driving, with M. holding his

rifle levelled on the elephant. The elephant neither moved nor gave any signs of ruffled feelings: it was the local Government Timber Elephant.

HONNAMETTI ESTATE, R. C. MORRIS.
July 10, 1929.

VIII.—ELEPHANT TUSK WEDGED IN A TREE

I have had brought to me to-day the broken tip end of an elephant's tusk which a Sholaga found tightly wedged in the fork of a limb of a tree. The piece is about 18″ long and the tip has been badly scored on both sides as if the elephant had been thrusting it between rocks, or crevices of rocks, or rubbing both sides against a rock, and this, combined with the fact that the tusk was broken off in a tree, seems to me to indicate that the elephant was possibly suffering a good deal of pain from an abscess, or a suppurating wound at the root of the tusk, and had been attempting to ease the pain in the manner above described.

HONNAMETTI ESTATE, R. C. MORRIS.
September 30, 1929.

IX.—THE DISTRIBUTION OF WILD BUFFALO IN ORISSA

(*With a photo and a map*)

I have noticed in books on sport and natural history that the 'coastal districts of Orissa' are often quoted as one of the habitats of the Indian Wild Buffalo (*Bubalis bubalis*). However true this may have been in the earlier days of last century, when buffalo frequented the neighbouring district of Midnapore in Bengal and parts of Balasore district as well, it is no longer a fact.

Orissa is composed of the three coastal districts of Balasore, Cuttack and Puri together with the Feudatory States lying between them and the Central Provinces.

Although buffalo undoubtedly had a much wider range in Orissa in former times, they are no longer met with in any of the above coastal districts and it must be many years since they became extinct there, although it is said that buffalo were to be found in Balasore district until twenty-five or thirty years ago. The few remaining herds are confined to Patna State on the borders of Raipur district of the Central Provinces, where they are found in two groups. There are some forty to fifty animals which frequent a locality within ten miles of the C.P. border, and a smaller herd of about fifteen individuals forty miles further east. It seems possible that the first named buffalo might join up with the herds in the south of Raipur district, but the local people assert that they do not.

A few wanderers are said to cross into the west of Sambalpur district from Raipur occasionally. It is, however, many years since any have been shot in the district, and they must be rare visitors in any case.

Although the area referred to is now included in Orissa, prior to 1905 both Patna State and Sambalpur district formed part of the Central Provinces.

The jungle frequented by these animals is extremely dry and to a great extent covered with a heavy growth of grass, which is three to four feet in height, in the early part of the cold weather. The forest consists mainly of small trees and saplings, and is rather open for the most part; so that when the grass dies down in the hot weather the cover becomes very thin. The waterholes and wallows cease to exist after the beginning of March and during the summer months the buffalo resort to the village tanks in the vicinity and wallow there by night, showing an astonishing disregard for the proximity of human beings. In fact their attitude at times is one of decided truculence.

On my first visit to this area I was surprised to find the buffalo affecting such dry and comparatively open jungle, as I was under the impression that they frequented damp and even swampy localities. It is of course possible that these forests were moister and more extensive in earlier times before the spread of cultivation and that the existing conditions are not really favourable to the existence of the buffalo. It struck me as remarkable to find such large animals in such dry and comparatively open jungle.

I have on several occasions seen these buffalo and I cannot say that I have found them wary, it being generally a fairly simple matter to approach within seventy or eighty yards of them. It is, however, difficult to distinguish the bulls from the cows at a distance, as the latter appear to be equally bulky and their horns are as long though not so massive as those of the bulls. It is on the whole better to avoid the herds and to seek out the solitary bulls if one is in search of a good head.

The accompanying photograph is of a bull shot in November, 1924. The horns, although not of great length, are massive. The measurements may be of interest and were as follows:—Height at withers (measured form heel) 64″; length of body along curve of spine 10 feet; tail 28″; girth behind shoulder 92″; girth of neck immediately behind ears 59″; girth of front thigh 23″; front cannon bone 11″; length of ear 13″. Greatest spread of horns outside 50″; ditto inside 42″; length of right horn along outer curve 42½″; ditto left horn 43½″; girth of right horn 20″; girth of left horn 19½″; tip to tip 37″; tip to tip around outer curve and across forehead 98″. Both horns were somewhat worn at the points.

A remarkably fine head shot in the same forest in 1919 had the following measurements:—Tip to tip across forehead 124″, length of right horn 53½″, length of left horn 52½″, girth of right horn 18½″, of left horn 20″, tip to tip 48″.

The buffalo in Patna State are, strictly speaking, the easterly outliers of the herds in Raipur district and Bastar State of the

Central Provinces. That buffalo were formerly more numerous and extended further east is unquestionable, and most probably their habitat extended from the C. P. through Orissa into Bengal at one time. In fact, there was at least one herd in Gangpur State near the Brahmani river until the early nineties of last century, when these few survivors were exterminated at the time of the construction of the Bengal Nagpur Railway main line.

Steps have been taken to preserve these fine animals in Patna

HEAD OF BULL BUFFALO SHOT IN NOVEMBER 1924

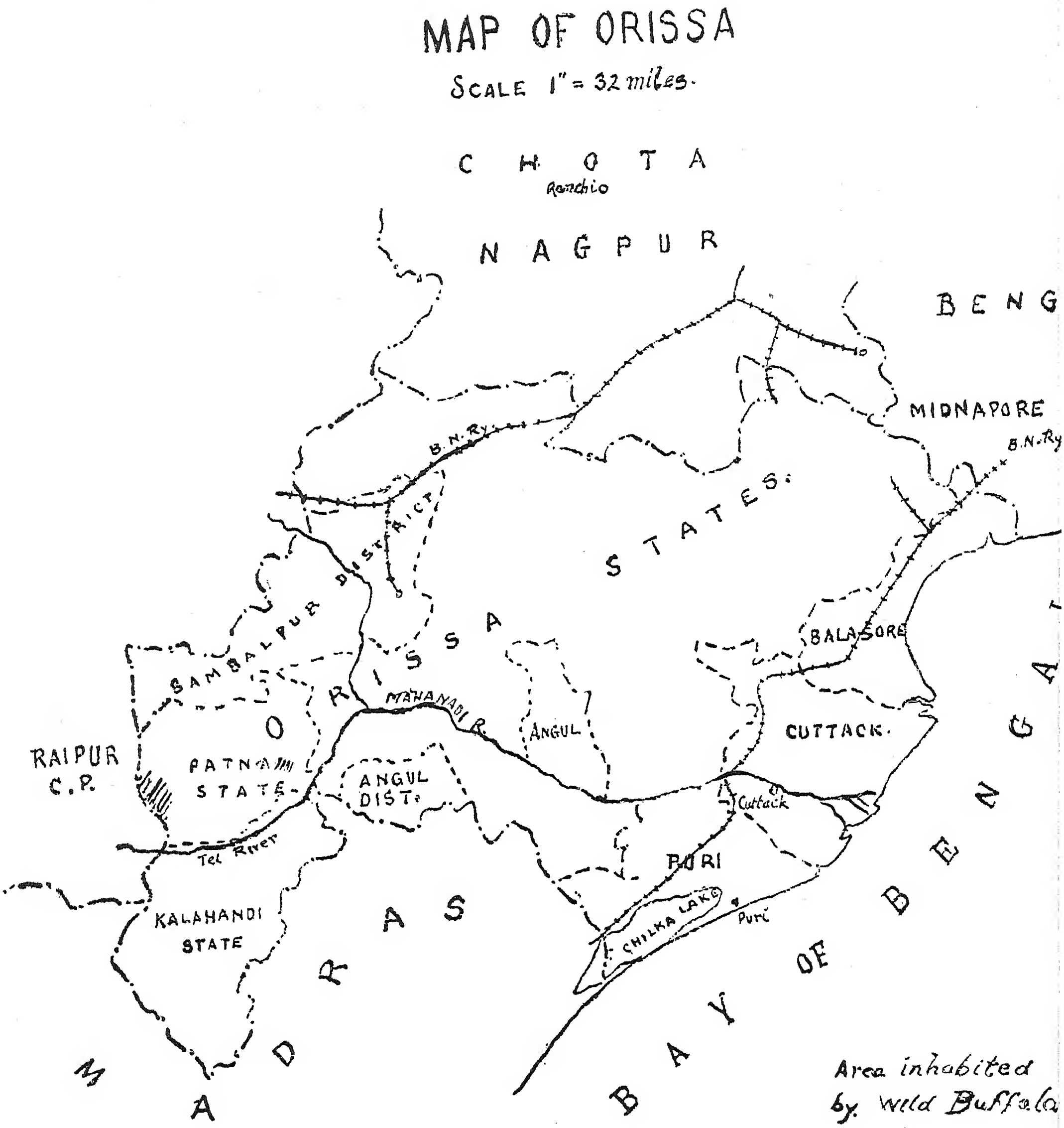
State and their shooting is strictly prohibited. They have been definitely on the increase during the past six or seven years and it is hoped that the construction of the Raipur-Vizianagram Railway through the area inhabited by them will not lead to any diminution in their numbers.

It is of interest that the smaller herd in the south-east of the State is showing a definite tendency to migrate south to an extensive and well-watered forest some forty miles away in Kalahandi State. They have crossed the Tel river every rains for the past three or four years, and on each occasion they have wandered further, and their stay has been more prolonged. It looks as if they are seeking a retreat more secluded than their present surroundings, where jungle is being steadily reclaimed for cultivation.

SAMBALPUR, B.N.RY.,
July 1, 1929.

H. F. MOONEY,
I.F.S.

Journ., Bombay Nat. Hist. Soc.



DISTRIBUTION OF WILD BUFFALO IN ORISSA

X.—MALFORMED CHEETAL HEAD (*AXIS AXIS*).

(*With a photo*).

MALFORMED CHEETAL HEAD.

I am directed by the Heir-Apparent of Bikaner to forward you two photographs of a cheetal stag, shot by one of the Nobles of Koteh State, which has 12 points. I trust this will be of interest to you.

LALLGARH, SURAJINAL SINGH,
BIKANER, *Secretary to The Heir-Apparent of Bikaner.*
August 10, 1929.

XI.—PARTIAL DISAPPEARANCE OF THE WILD PIG (*SUS CRISTATUS*).

In recent years the partial disappearance, and in some parts the complete disappearance, of the Wild Pig from jungles in the Kollegal Taluk of the Coimbatore District is very marked, and can only be attributed to, in my opinion, the increasing numbers of Wild Dog. Whereas in previous years sounders of pig abounded all over the Billigirirangans and the country east of the hills, they

are now rarely seen and, further east, on the Baragur Hills, they have completely disappeared. Locals on both these hills, the Baragurs, and the country in between agree that the Wild Dog is the chief cause of their diminution in numbers.

Some years ago a pack of Wild Dog attacked a sounder of pig near my Bungalow and killed two sows in a few minutes. It will be interesting to learn whether this is occurring in other parts of India.

HONNAMETTI ESTATE, R. C. MORRIS.
July 2, 1929.

[It is gratifying to note that the Madras Government have recently re-introduced the payment of rewards for the destruction of Wild Dogs.—EDS.]

XII.—BIRDS OF QUETTA

In the Journal (Nov. 1926 to Aug. 1927) I dealt with such information as was known about the Birds of British Beluchistan. I was therefore very pleased to see a further interesting paper on Quetta birds in the last Journal from the pens of Messrs. Williams, and they must not mind my asking a few questions and making a few comments about some of the species they list.

The Kashmir Magpie ten years ago had become very scarce in the Quetta valley where it once was common. It now seems to have picked up in numbers again.

The breeding of the Chough at Ziarat is certainly nothing new, as suggested by Major Williams. It has been recorded by several authors whose observations were epitomized by me in the *Birds of Beluchistan* (*J.B.N.H.S.,* Nov. 1926, p. 6).

The nesting of the Willow-Warbler (*Phyllocsopus nitidus nitidus*) is very interesting; but was the bird obtained to prove indubitably that it was this Warbler that was nesting in the Marachak Reserve? Otherwise, I fear there must always be some doubt about it. It is of particular importance of course as this bird has never been known to breed within Indian limits before for certain and according to the *Fauna,* ed. ii, nothing for certain is known about its nidification.

The nesting of Barne's Chat is also new and here again I trust a specimen was secured for identification as some of these chats look very similar. An interesting addition too is the Red-tailed Wheatear as a breeding species, though not very unexpected. Fortunately it is a very distinctive bird in the field.

Three races of Asian Goldfinch have occurred in N. Beluchistan in winter. Is the identification of the breeding race made from a series of breeding birds?

Messrs. Williams consider the Beluchi Sparrow to be *indicus;* they give no reason for this. I examined a good *series* of these

and came to the conclusion it must be called *parkini*. I suppose it is quite certain that the nests in the thin branches of trees were those of the Tree Sparrow. I searched the country outside Quetta in the autumn in vain for this sparrow and all I saw were in the town itself, and concluded that they nested in the usual sites in holes in buildings.

Again I must ask if it is quite certain that the Crag Martin which nests round Quetta is the Egyptian bird *Ptyonoprogne obsoleta obsoleta*. The bird of S. Beluchistan, Sind and the Bolan is *Ptyonoprogne pallida* (*J.B.N.H.S.* xxxi, p. 869). The common Crag Martin round Quetta is *Ptyonoprogne rupestris*. If there is no mistake over the nesting of the Indian Cliff-Swallow at Mastung, this is a tremendous extension of range, as this bird is not known to breed in S. Punjab, Sind or in the rest of Beluchistan. Were specimens obtained?

It will be noticed that, when I wrote the *Birds of Beluchistan*, I could not determine which race of Cuckoo bred in N. Beluchistan (*J.B.N.H.S.* xxxi, p. 880), and that I had only seen two specimens thence, neither of them breeding birds for certain, and these two were not *telephonus* but corresponded with *sub-telephonus* of Zarudny. If Messrs. Williams have not examined a breeding series, it would have been better to have left their records under the binomial name.

I have seen no breeding Kestrels from Beluchistan. All birds I have examined, winter birds and possible breeding birds from Kandahar, belong to the typical race and it would have been better, had Messrs. Williams stated what evidence they had that the breeding form is *interstinctus*.

Though the authors of this paper record *Streptopelia senegalensis ermanni* as the breeding bird at Quetta, there is no doubt that the bird nesting there is the Indian *cambayensis* (vide *J.B.N.H.S.* xxxii, p. 73).

The nesting of the Quail near Quetta recorded by Meinertzhagen appears to have been overlooked.

APPLEDORE,
KENT, CLAUD B. TICEHURST.
September, 1929.

XIII.—THE INCUBATION OF EGGS DURING THE HOT WEATHER

The following cases of eggs hatching during the hot weather, after several days' desertion by the parent birds, may be of interest. In May last a Bulbul nested in a fernery adjoining the porch of my bungalow and was sitting on three eggs for about a week. On the 27th idem, I saw the bird sitting, but on the following day neither of the parent birds appeared. In the evening I inspected the nest

and found only one egg; the birds were not seen again either on the nest or in the vicinity.

On the evening of May 30th, three days later, I again inspected the nest to see if the egg was still there and found it in the process of hatching. Later, I removed the shell and covered the nest with cotton wool for the night.

In the morning my wife and a friend fed the squeaker with white ants; he opened his mouth willingly and took the decapitated corpse of a white ant eagerly at intervals. By about noon he was quite strong and, when opening his mouth for food, emitted a mild 'cheep'. I am inclined to think the parents heard this mild cheeping as they appeared in the fernery and seemed somewhat agitated. We immediately replaced the squeaker in the nest and watched. The old birds returned but did not go to the nest—and then the tragedy?

We could not actually see the nest from the verandah; but a peon watching it rushed in a few minutes later to say there was a reptile at the nest. I went out quickly with ·22 rifle loaded with a short cartridge to find a 'bloodsucker' (*Calotes versicolor*) with his head in the nest. I shot him, but too late, he dropped the mangled remains of the youngster from his mouth. I might mention that about ten days previous to this tragedy, when there were only two eggs in the nest, a Koel found it but was driven off. During the afternoon he returned and on hearing much protest from the parents, I went out with my ·22 rifle to find the enemy sitting on the top of the fernery looking into the nest, being buffeted by the old birds.

I am glad to say he paid the penalty and I hoped after that my Bulbuls would be safe. Unfortunately not, the tragedy described above was the finale.

There are three interesting points in this occurrence:

The hatching of the egg after complete desertion by the parents for three clear days.

The loss of two eggs only which caused the birds to desert.

The return of the marauder to the nest only a few minutes after the squeaker had been replaced.

The disappearance of the two eggs I attribute to a bloodsucker; but why did he not return for the other egg later?

I had frequently seen several of these reptiles in the roof of the fernery and in the past all efforts of other birds to nest in the fernery have resulted in failure, the eggs disappearing mysteriously.

In connection with the hatching of eggs without further incubation by the parents, I can give another instance which occurred in Ahmednagar during the hot weather of 1922.

A hen sitting on ducks' eggs died on the nest after 22 days' incubation. Although the eggs were cold when found, they were kept near the fire in the kitchen until another hen could be procured some hours after. The following day the substitute 'broody' was found standing under her basket cover, she had laid an egg and the ducks' eggs were again cold.

I put the eggs in another nest intending to use them for testing another broody hen. After three days, one of my hens became

broody and I put her on the eggs on trial. After four days, on going to put fresh eggs under her, I found a duckling hatching and during that day and the following day five ducklings hatched from the original twelve eggs.

The total period of incubation, including the three days during which no hen was near the nest, was 33 days.

Probably such cases are fairly common, but I do not remember having seen instances of them noted in the Society's Journal.

This incident occurred early in May, when the day temperature in Ahmednagar would be a maximum of about 105 and a minimum of 85.

In connection with the above notes, I should like to know whether the bloodsucker is an asset to a garden or not?

I believe he destroys a lot of grubs, caterpillars and the like, but I caught him in the act destroying my bulbuls and I prefer birds to flowers.

I have waged war on him since, and my bag up to date is twenty-two.

5 Arsenal Road,
Poona,
September 17, 1929.

C. O. LOWSLEY,
P.W.D.

[The tendency to brood is a normal element in the cycle of reproductive activities of the female bird. With some species such as Hornbills, Hoopoes and the Eagle-Owl this duty is performed exclusively by the female. With the Rhea and Emus incubation is carried out by the cock bird alone. With the Common Sandgrouse the cock bird sits by night and the hen by day, but with the majority of species both parents brood in irregular alternation. In hot countries such as India, many birds seem to trust to the heat of the sun to hatch their eggs and incubation is relaxed to a great extent during the day. Hume (*Nests and Eggs of Indian Birds*, Vol. I, p. 378) refers to four young mynahs which hatched out without any apparent effort on the part of the parents at incubating the eggs by day. Dewar (*Indian Bird Life*, p. 237) mentions the emergence of three young Pond Herons from eggs which he had taken from the nest and placed in a vase three days previously. In the hotter parts of India, the effect of the direct rays of the sun on eggs which are not protected by cover of any sort may be strong enough to cook them; the body of the brooding bird may then become a shield from the sun. Common Sandgrouse, which frequently nest in bare open plains where the eggs are exposed without the protective cover of scrub or grass or stone, never leave their eggs uncovered during the hottest part of the day. Similar conditions make the Cream-coloured Courser a very close sitter. We have had an instance nearer home. In Bombay our local crows took very readily to building their nests on the brackets carrying the overhead electric railway cables. Within the city limits, these nests are usually built of wire or hoop iron. The nests are not sheltered in any way and are exposed to the direct rays of the sun. It was noticed that the crows brooded in the wire nests during the

hottest parts of the day but did not sit in them by night; they roosted in the neighbouring trees. The nests were hot to the touch even at 2 a.m.

Desertion of the nest after it has been tampered with varies not only with different species but also among birds of the same species. Some birds will continue to sit after some of the eggs have been stolen or if the nest is handled in any way, while others of the same species will desert the nest on the slightest provocation.

The common bloodsucker (*Calotes versicolor*) is mainly insectivorous—that he occasionally robs nests is evident from the above note. But we could hardly recommend his extermination on these grounds.—EDS.]

XIV.—THE TAIL-RACKET OF *DISSEMURUS PARADISEUS*

I am grateful to Mr. Salim Ali for having pointed out a mistake in my paper on the Study of Indian Birds regarding the racket of *Dissemurus paradiseus*. Mr. Salim Ali is wrong in assuming that I copied my information from the two editions of the *Fauna;* I examined the specimens in my collection very carefully and drew the illustration from one of them. Mr. Salim Ali seems to think it curious that the illustration agrees with the condition described, but he does not suggest how the condition should be otherwise illustrated as in fact the racket is borne in such a position that it appears to be the outer web; that it is not so is not apparent to my eyes, either naked or with a lens. If, however, the shaft of the feather is drawn slowly through the tightly closed nails of the finger and thumb, it slowly rotates, from which I accept Mr. Salim Ali's contention that, what appears to be the outer web, is really the inner web. It is an interesting point and one must assume, I suppose, that the weight of the rackets was originally responsible for the twist in the feathers.

BATTLE, SUSSEX, HUGE WHISTLER.
August 18, 1929.

XV.—NOTE ON THE NESTING HABITS OF THE SOUTHERN RED-WHISKERED BULBUL (*OTOCOMPSA EMERIA FUSCICAUDATA*)

The fourth reappearance of this bird, to nest in a fern-pot in my verandah, reminds me that I made some notes of its appearances on former occasions. A pair of the birds first built their nest in a hanging pot of ferns in the verandah in front of my drawing-room during the first week of last September. Only two eggs were laid, but this small clutch may be explained by the comparatively large size of the eggs as compared to the hen bird. The nest was composed entirely of casuarina leaves, very neatly and closely woven together, and this same nest has served to rear three successive broods in without anything being done in the nature of

repairs. The two young birds which resulted departed some time in October and were fed fearlessly by the parents although we sat to have our afternoon tea daily within a yard of the nest.

The parent birds reappeared again towards the end of November when, again, two eggs were laid and successfully hatched out. The third appearance of the same two birds was in March, twin fledglings resulting for the third time. A few weeks before this we had invested in a cat, and I rather feared that this animal might scare our lodgers away. They evinced no fear whatever of it however. One night, during a particularly heavy thunderstorm, the hen-bird, which was sitting on the eggs, flew from the nest into the lighted drawing-room, apparently scared by the lightning and crashing thunder. The cat immediately pounced upon it, but was in its turn pounced upon by the servants and the scared bird released from its jaws, apparently quite unharmed. It was restored to its nest and I was much surprised to find it sitting peacefully on the nest on the following morning. One of the young birds left the nest a day before the second and the parents were greatly put to it to prevent the first from straying whilst they continued to feed the second. This latter left the nest on the following day but was unable to fly, and finding it on the ground, one of the servants placed a wicker basket over it to prevent the cat getting at it. Shortly afterwards, I found the parents sitting on top on the inverted basket trying to feed the prisoner. I, thereupon, upturned the basket, caught the second fledgling and placed the basket in a croton bush in the compound. I rather feared that this would scare the parents away and that the young birds would be deserted. My fears were groundless, however, the birds followed me and at once took over their offspring, the whole party leaving us two days later.

From May onwards, the birds have not been seen, but to-day, the 16th August, they are back again and now busy trimming up the nest, which is a little the worse for wear from the monsoon and the Mali's attentions.

It would appear, therefore, that these birds nest thrice yearly, laying two eggs on each occasion, the nesting season ranging from September to early May. A pair of these birds built their nest in a similar situation in my bungalow in Mercara, Coorg, 1923, so that it would appear to be a habit of the species.

(N.B. Since the above was written, the mother bird has laid two eggs and the fledglings are already half-grown.)

CALICUT, F. C. FRASER,

September 19, 1929. *Lt.-Col., I.M.S.*

[The Southern race of the Red-whiskered Bulbul usually lays two eggs in a clutch—occasionally 3—while the Northern race (*O. e. emeria*) normally produces three to four. Baker (*Faun. Brit. Ind.*, new ed., Vol. I, p. 396) gives March and April as the breeding season, but states that many nests may be found between February and August and odd ones in almost every month of the year. The fecundity and fertility of birds, though innate in many

species, may be influenced by external factors such as environment and the abundance or scarcity of the food supply.

Ticehurst has shown (*Birds of Sind,* Ibis, July 1922, p. 544) that the White-eared Bulbul (*Pycononotus l. leucotis*), which normally breeds in Sind between March and April, repeats the performance in June and September in years when the rainfall provides plenty of leafy cover and abundant food in the shape of fruit and insects.—EDS.]

XVI.—MIGRATION OF THE PIED CRESTED-CUCKOO (*COCCYSTES JACOBINUS*)

With reference to Whistler's note on the 'Migration of the Pied Cuckoo' and in continuation of my letter of 15th April, I am writing to inform you that I have been specially on the look-out for the first appearance of the Pied Cuckoo this year in the neighbourhood of Ajmer.

On Sunday, 30th June, the weather was very sultry, and towards afternoon thunder clouds began to gather on the horizon threatening rain before night. Such were the conditions when I saw the Pied Cuckoo for the first time.

It was about 5 p.m. and the place was the hill range between Ajmer and Nasirabad. These hills are quartzy and are covered with thorny scrub and spurge and are typical of all the hill ranges round Ajmer.

I had been on the spot for about half an hour and was just about to retrace my steps towards the road and my car because the storm was about to burst, when I heard the bird call in the distance; the call was repeated at intervals, coming closer and closer, until the bird flew almost directly over my head. At the same time the first drops began to fall. I heard it no more that evening, although I remained in the locality till sunset, the rain having lasted less than half an hour only.

The rainfall has been rather unusual and irregular here this year. There were heavy showers at the end of May and the middle of June: from the middle of June onwards, the conditions were generally monsoonish though the rainfall was negligible. Grass had begun to grow and the thorny scrub was bursting into leaf.

I had been on the same spot, sitting up for a panther, or birds nesting, every Sunday throughout June, except the 9th, without seeing or hearing the bird. On the following Wednesday, the 3rd July, I saw two birds fly into a babul tree on the Golf-course which lies under a hill called Madar. The same night there was heavy rain.

Since then I have seen numerous Pied Cuckoos on *every* occasion on which I have entered any of the hill ranges round about Ajmer.

The bird may therefore be termed common in such situations. I have since seen the bird on two occasions in Balul, Kikar Jungle, at considerable distances from any hills.

Its coming seems to coincide with that of the Rain Quail whose whistle is now to be heard in any grass land, whether in the compound or further afield.

AJMER, R. M. SIMMONS.
August 4, 1929.

XVII.—AN ALBINO HOUSE SPARROW (*PASSER DOMESTICUS*)

For the last two or three years I have been noticing an absolutely pure specimen of an albino house sparrow regularly paying its visits in the company of ordinary individuals of this species, in the garden of one of the hostels here. As is only to be expected, this bird, with its pure snowy white, forms a very conspicuous and interesting contrast with the commoner ashy-gray or dull-brown colour mixed with dirty white of other individuals, the contrast being specially heightened when the flock is in flight. Judged from the colour of the bill, the bird in question is probably a female, unless of course it is the case of a cock in which albinism has affected even this member. I do not, however, know if such a thing ever takes place.

This bird has been living and nesting in the company of others and they seem to take no special notice of its freakish nature. One thing, however, is surprising. Presuming this bird, whether a cock or a hen, to mate freely, it is difficult to understand the absence of other pure or partial albinos. Judging from the breeding habits of the species, the birds must have brought up several broods during the last two or three years, and yet not another bird, whether purely or partially white, has ever been noticed.

BENARES HINDU UNIVERSITY, N. K. TIWARY.
October 16, 1929.

XVIII.—MIGRATORY HABITS OF WAGTAILS

Although only a casual observer of bird life, I have been repeatedly very much impressed by the extremely regular migratory habits of some of them. In particular I was led to note, with a certain amount of care, the appearance of the White Wagtail (*Motacilla alba*) in U.P. for a number of years. I have noticed these birds appear in some of the towns with a surprising degree of punctuality—in fact within one or two days of the 21st of September each year. For the last three years, however, I find that they have become very erratic in their movements. This year particularly I did not notice a single individual until about the end of the first week of this month. And even on this sixteenth day of October, only stray birds are occasionally seen. Last year also very few

individuals were to be seen and they likewise appeared long after their due date of arrival. I should like to know if the same irregularity has been noticed by others and, if so, what may be the probable reason of the want of punctuality as well of the very small number of the individuals.

BENARES HINDU UNIVERSITY, N. K. TIWARY.
October 16, 1929.

XIX.—THE MATING OF THE BLOSSOM-HEADED PAROQUET (*PSITTACULA CYANOCEPHALA*)

In Vol. XXXII, No. 1 of this *Journal,* Mr. Salim A. Ali had contributed an interesting note on 'The Mating of Paroquets.' Therein he had described what he called 'extraordinary antics indulged in by the bird.' It appeared, however, from his note that the mating habits of these birds were imperfectly known. At any rate, judging from my own observations, he seemed to miss certain preliminary details. Not, however, being an ornithologist myself, I was looking to his account being commented upon by others. It would now appear that this subject has not received the attention from others or that there is nothing further to be added to the account given by Mr. Salim A. Ali. It may therefore not be out of place, even after this lapse of time, to publish these remarks.

The observations that I am about to record were casually made a number of years ago and relate to birds that were kept as pets. The male and the female had at first their own separate cages but subsequently had to share the same for some reason. For a time the original owner naturally could not brook any encroachment on personal liberty by a stranger and the two birds kept fighting. In course of time, however, they reconciled themselves to the inevitable and even became friendly. Not very long afterwards also they began to behave in what at first appeared to be a curious manner. They would, for instance, at first tickle each other with their beaks which subsequently would appear to become locked together. On closer examination, however, it was found that, while in this state, the regurgitated contents of their crops were being apparently exchanged. During these proceedings, and afterwards also until copulation took place, the pair was continuously uttering what I can only describe as a series of squeaks and cackles. After this state of affairs had gone on for about two or three minutes, the male would climb up the back of the female who would crouch down to receive him, and, then, as stated by Mr. Salim A. Ali, 'commenced a series of some extremely odd proceedings difficult to describe.' The subsequent story is essentially as related by him.

I have never again seen these birds mating and I am therefore unable to say whether the facts here described are a normal feature in the breeding operations of these birds. Those, however, who have studied their habits more closely, would be able to throw light on the subject.

In conclusion, I might also add that with these caged birds mating took place at any hour of the day and was not confined to early mornings, as mentioned by Mr. Salim A. Ali.

BENARES HINDU UNIVERSITY, N. K. TIWARY.
October 16, 1929.

XX.—LATE STAY OF GREY QUAIL (*COTURNIX COTURNIX*) IN BIHAR

While riding over a portion of the Gogra Diara (river bed) on the 23rd of June, I put up a large number of Grey Quail out of the tall grass through which I had a line of beaters beating for pig. It struck me that it was unusually late for this quail. This note may elicit similar observations made by other members.

URNA ESTATE, A. MACDONALD.
MAROWRAH P.O.,
B.&.N.W.RY.,
August 15, 1929.

XXI.—BREEDING OF GEESE AND DUCKS IN CHINESE TURKISTAN

The following might be of interest. It was noticed that the following birds had their young hatched in the first week of June on the Tekkese River, 50 miles below Shotta.

Grey Lag Goose	(*Anser anser*)
Bar-headed Goose	(*Anser indicus*)
Brahminy Duck	(*Casarca ferruginea*)
Mallard	(*Anas platyryncha*)

BRITISH CONSULATE GENERAL.
KASHGAR, G. SHERRIFF,
July 18, 1929. *Capt., R.A.*

XXII.—HOW THE MONITOR LIZARD SITS IN ITS BURROW

In the last week of July this year, the Zoology staff and Post-graduate students of our college, accompanied by three snake-charmers, went out into the jungle round about Midhaku, a small village near Agra. The purpose was to see the *fauna* of this place in its natural haunts. Besides catching several centipedes, insects, snakes and other animals, we secured eight monitor lizards (*Varanus bengalensis*), which are quite common here. The snake-charmers had a remarkable sense of recognition of their traces. My attention was especially drawn to the bold way, in which, after digging a burrow waist-deep with the *kudal*, they would half dive into it and fearlessly drag out a big, struggling specimen by the tail. The monitor has strong jaws, and can give a bite not easy to forget. Last year a snake-charmer was bitten,

and after many futile efforts to release his finger from inside the reptile's mouth, we had, as a last resource, to cut the jaws open with scissors. It was a terrible bite! In spite of such experiences, however, the snake-charmers do not seem to think much of risking their heads and hands in a monitor's burrow. On enquiring, I learnt that the creature has the habit of always sitting in the burrow with its tail nearer, and its head away from, the opening. Once the tail is caught, it cannot turn its clumsy length round to bite at the offender, and the catcher is safe.

BENI CHARAN MAHENDRA,
Lecturer in Zoology.

ST. JOHN'S COLLEGE,
AGRA;
October 26, 1929.

XXIII.—OCCURRENCE OF THE RUSSELL'S VIPER IN THE BRAHMAPUTRA VALLEY

In Colonel Wall's book on Poisonous Indian Snakes he states that the Russel's Viper is not found in the Brahmaputra valley. I personally have seen two undoubted specimens in this district which lies close to the Bhutan foothills. I have a specimen at present in my possession which corresponds accurately with the description, detailed and general, given in Colonel Wall's book. If you wish, I will send the specimen to you for confirmation; but as it is my only specimen of this snake, will you please undertake to return it?

PANEERY, J. LOUDON.
PANERIHAT P.O.,
August 17, 1929.

[The snake forwarded to us by Mr. Loudon is a Russell's (*V. russellii*).—EDS.]

XXIV.—THE DISTRIBUTION OF THE BANDED KRAIT (*BUNGARUS FASCIATUS*)

On October 24th I was motoring in the Sal forest some five or six miles from Gorakhpur, and was making a sharp hair-pin turn from one of the narrow forest cuttings to another. The time was about 6.45 and it was pitch dark.

A large snake, which was coiled up on the path, unwound when my headlights struck it, and made off into the jungle. I tried to run over it, but am not sure if I was successful, as my wife would not hear of my going back to make investigations. The snake was so brilliantly banded, and these bands showed up so well under my headlights, that it seemed a definitely characteristic one. The same evening in the Club the matter was discussed and the consensus of opinion was that it was a Banded Krait (*Bungarus fasciatus*).

I have since referred to Colonel Wall's book, and there seems little doubt that the identification is correct. I should say the specimen was about five feet long. The only reason for my writing is that the furthest western limit given by Colonel Wall is Bettiah in the Champaran District. Gorakhpur District is still further west, the Gandhak River intervening.

GORAKHPUR,
B. & N.W.RY.
October 26, 1929.

JAMES MASSON
Lt.-Colonel, I.M.S. (Retd.)

XXV.—A DUEL BETWEEN A CAT AND A COBRA

I wonder if any reader has ever heard of a fight between a cat and a cobra? If he has not, the following incident, which actually took place, may be of interest.

The cat in this little drama belonged to me. Formerly she was a stray cat and half 'Jungly', but we gave her a home and she became a great pet of our family. In the ordinary course of events we went to England but before our departure we left Billikins with a bachelor friend, and in due course she became as attached to him as she had been to us.

When the hot weather arrived, our friend followed his usual custom of sleeping out-of-doors, and Billikins, most faithful of animals, usually followed him when he retired for the night, seldom wandering far from, and often herself sleeping under, the bed.

One night our friend was wakened by a hissing sound which seemed to come from somewhere close by. He sleepily noted that it was a bright moonlight night, and was just dozing off again, when a second louder 'hiss-s-s', followed by a growl and a spitting noise from a cat, raised his curiosity and indicated that some drama—of an unusual kind—was being enacted under his bed!

Carefully lifting up a corner of his mosquito net and peering underneath, he discovered Billikins engaged in a mortal combat with a big, black, cobra about a yard long. The cat was crouched, with tense muscles, never taking her eyes from the snake, while her dangerous opponent was sitting up, slowly swaying from side to side! And then, with awful suddenness, came the inevitable strike! But, quick as lightning, the cat had jumped to one side, and, in the act of retreating and while the cobra's head was still lowered, had got in a tearing blow on the back of his neck with her claws.

The drama continued!

The cobra raised himself, and again he struck, only to receive another blow on his head, and to miss his quarry. These tactics were repeated time after time, until at last the wounded snake crawled away leaving the heroic little cat mistress of the field.

The next morning the cobra was found dead in a ditch close by, with its neck and head torn to ribbons.

'MULLACLOE', (MISS) H. VICK.
NAINI TAL, U.P.,
June 25, 1929.

XXVI.—NOTES ON THE RARER LYCÆNIDAE

Tajuria ceeta, Den.

Has many broods. I have taken many perfect specimens from November to May. A sure find is the evergreen tree growing in and round Jheels or Ins in S. Burma. Time 1 to 3 p.m. In any glade where the light filters through. Never taken above 15 ft. from the ground.

Locality.—Salween, Pegu, Thaton, and Moulmein districts.

Tajuria ogyges, Den.

Many broods, November to May. In Thaton district, found with *ceeta*. In Moulmein, Ataran and Haungtharaw Valleys, on the larger streams, flying around the orchids growing on the Pyinma trees (*Lagerstrœmia flos reginæ* Retz) ♂♂ taken from machans 30 ft. and over from the ground ♀♀ in the scrub below. ♂♂ on the wing from 1.30 to 3 p.m.

Tajuria donatana, Den.

I have only seen this on a peak between the Ataran and Haungtharaw Valleys near the Siamese border in April. This peak had been cleared for a survey station. The insects appeared at 11 a.m. and began chasing one another round the peak flying about 4 ft. off the ground, and settling on trees down the spur well out of reach. A branch from one of these trees planted on the top gave me 5 perfect ♂♂ specimens in about an hour's time. They stopped flying at 1.30 p.m.

Charana mandarinus, Hew.

♂♂ always found on hill tops, usually on the underside of leaves. I have taken them at all hours. ♀♀ seen ovipositing on the smaller stems of mango trees.

Tails held straight when sitting.

Jacoona anasuja, Fd.

I have taken about 30 ♂♂ and 5 ♀♀ of this beautiful species, and seen about as many more, only on hill tops. I have taken it here in Maymyo on an oak tree from July to October. In Thaton, it is found on Kalama Taung 3,022 ft. in November-December, where it settles on the scrub. In the Salween district, I took it on a large wild mango tree from a machan 25′ off the ground at 600 ft. December-May. In Moulmein, I took it on all kinds of trees. In one case, off bamboo, where Brig. Evans' collector, James also took it. In most cases it prefers trees with a branch or two which are about 20 to 30 ft. above ground.

The ♀ is the first to appear. She usually comes at 10.30 a.m. and makes two or three very short visits to the tree on which the ♂ ♂ appear at 11 a.m. (never earlier). I saw one which had a big piece taken out of her wings make 4 visits, the last at 12 a.m. A ♂ which arrived just as she left flew off after her, she did not return to the tree again. ♂ ♂ and ♀ ♀ do not remain after 1 p.m. I have lost numerous ♀ ♀ through waiting for them to settle, which, I have not seen one do yet. The ♂ ♂ when they first appear usually alight on the upperside of leaves, preferably a leaf which is bent downwards. Later, during the day, they alight on top of a leaf and walk underneath and remain with head always pointing downwards and wings always closed. As seen from my machan the sight of 6 ♂ ♂ below me chasing one another round is one I will never forget.

From the leaf the insect starts its flight with the wings open on a fast glide. I have seen them loop the loop without closing the wings once. The flight ordinarily is a series of arcs, the direction of flight being changed at the end of curve by a quick closing of the wings. The tails are always held straight. This peculiarity is also shared by *Manto, Mantoides, Neocheritra* and *Purlisa* and is easily noticed when they are sitting. All the other long-tailed *Lycænidae* curl up the ends of their tails.

Manto hypoleuca martina, Hew.

Karen Hills, from which it has never been recorded, is the only place where I have seen and taken this variety. In a deep glen of the Meto Law at 1,000 ft., Salween District, on 25th and 26th December, 1926, I saw about a dozen specimens, between 3 to 4 p.m. sitting with their wings open about 30 ft. off the ground on trees overhanging the stream, getting the last of the sun. I only took two after a nasty climb up a tree and a longer handle to my net. Tails held straight when sitting.

Mantoides licinus, Druce.

I have taken this from the same machans as I have *Jacoona*. I have not seen it in Maymyo. Any hill top with evergreen jungle on the north and east slopes from the Karen hills in the Salween District to Mergui is a likely find for this. 11 a.m. to 1 p.m. I have not seen more than a couple of dozen in eight years in Burma. In Mergui I found it with *Neocheritra amitra*. November-May. Tails held straight.

Neocheritra fabronia, Hew.

I have only seen this at the camping ground on the east face of the Dawnas at 3,400 ft. on the road from Hlaingbwe (Thaton District) to the Thaungyin Valley. The ♂ ♂ flying about 4 ft. above the ground looking like a frayed bit of blue ribbon. The ♀ ♀ in the jungle on both sides of the open spur which forms the campaign ground. Tails held straight.

Neocheritra amitra, Fd.

♂ ♂ flying between 1 and 3 p.m. always from south to north. Only seen and taken in Mergui from 11 a.m. to 1 p.m. with

Mantoides licinius—stays high—sits on upper sides of leaves. November-May.

Purlisa gigantea, Dist.

This lovely insect had not been recorded from within our limits before I took it in the Ataran Valley-Moulmein. I took two specimens sitting on the underside of bamboo (*Thrsostachys siamensis*) leaves, in April, in burnt out jungle where one would not expect a common butterfly. It is apt to be overlooked when flying as the blue on upperside is the same as that of a *Dacalana* but the flight is like that of *Jacoona*. Tails held straight. This butterfly was wrongly credited as having been taken by me in Mergui by Brigadier Evans in Vol. XXX, Note 9(*a*) at the end of the *Lycænidae* Family. He probably overlooked the notes I sent him at the time.

KILREA,
MAYMYO,
September, 1929.

G. E. R. COOPER,
Survey of India.

XXVII.—A NOTE ON SOME MALABAR LEPIDOPTERA

Looking through Brig. Evans' lists of butterflies which occur in the South of India, I notice that there are several species which he mentions as rare or very rare, but which actually are not at all uncommon. Of these, five in particular have at various times forced themselves upon my attention, although I have not been taking any particular interest in them. I have been able to make the following brief notes about these species :—

1. *Papilio buddha*.—Moderately common from May until the end of September and quite common during the latter end of August. I have seen as many as a hundred in my own compound at Calicut, but, owing to their shyness and rapid flight, have not often secured them; ten was my biggest bag made in the course of one hour. Perfect specimens are rarely taken, but their wings being remarkably tough, they do not often fracture in the net. On the wing it is one of the most superb insects, its wings spread wide show to perfection the wonderful display of shot blues and greens. At the foot of the Vayitri Ghat, along the telegraph jungle line, it may be seen in great numbers, but all flying high; in Calicut it shows a predilection for lantana blossom on steep hillsides, where it may be taken after a long tiring stalk.

2. *Papilio liomedon*.—Found on hills from the 15th to 30th miles on the Vayitri-Calicut road. A wary, restless insect, keeping to dense jungle, but seen very occasionally whilst crossing clearings. Last year, during September, I saw eighteen specimens in the jungle at the foot of the Vayitri Ghat and secured five of them. In May last I came across it in plenty in the Kallar Valley, Annaimallais at 3,500 ft. Specimens were continually crossing the river-bed, following the line of the jungle and vanishing into its depths at intervals. So wild were these specimens that I did not succeed in securing a single one.

3. *Parantirrhœa marshallii.*—A not uncommon butterfly at Lakati, at the top of the Vayitri Ghat. The insect is a riverine one; so is apt to force itself upon my attention when wading up streams after dragonflies. Its larva feeds on cane and the insect is thus rarely seen away from the neighbourhood of cane brakes. Although gifted with a weak flight, owing to the dense nature of the thickets it frequents, giving one no room to play a net, it is quite difficult to take. Recently I took three specimens in about twenty minutes and I should conjecture that a collector, especially out for them, could take a score in the course of a morning. Lakati is a very similar locality to Watacolle, Coorg, where Winkworth has taken this insect. I possess a specimen taken near Trichur, Cochin, some years ago.

4. *Zipœtis satis.*—Taken in the same locality as *P. marshallii* but a much more common insect. At Lakati, in August, it is quite the commonest Satyrine and may be flushed up every few yards. In spite of the dense thickets, I took eight specimens in about ten minutes recently. I saw it quite common in the Cochin jungles at Kavali last September and it is not at all uncommon on the Nilambur Ghat, Nilgiris.

5. *Prioneris sita.*—I was shown a specimen of this insect, which so remarkably resembles *Delias eucharis,* by Mr. Florence of Coonoor last year and remarked that possibly the large numbers of insects which I had seen at Lakati, and which I had thought to be *D. eucharis,* would be *P. sita.* When at Lakati next I discovered that both species were in company but *P. sita* in overwhelming superiority. As would be expected from the shape of its wings, its flight is much more strong and swift than its mimic and so it is quite easily determined on the wing.

It foregathers with *Catopsilias* and *Appias* on wet sand beside the river at Lakati and it is in such numbers during September, that one can quite easily dab the net down on half a dozen or more as they cluster together. The insect is a sub-montane one and it is soon lost to sight as the Vayitri Ghat is descended, *D. eucharis* on the other hand becoming increasingly common. Whilst the latter insect is to be found all the year round in Malabar, *P. sita* is single-brooded and appears only during September to October.

F. C. FRASER,
Lt.-Col., I.M.S.

CALICUT.

XXVIII.—DWARF SPECIMENS OF BUTTERFLIES

(*With a plate*)

The annexed plate shows, along with a normal-sized specimen, a dwarf male *Papilio polymnestor,* Cr., caught in Sambalpur, Orissa. It has, besides its diminutive size, the following peculiarities :—

1. The black, subterminal spots on the hindwings are round rather than oblong or quadrate, and much smaller than the discal spots. That in interspace 2 is specially small.

2. The ad-nervular blue streaks on the forewings go further round the apex than in any specimen of the long series in the British Museum.

There is a prominent red streak in each forewing cell. There is a faint trace of red in one or two males in the British Museum, but none are as in this one.

Other small specimens, all, like this one, captured in the wild state, are shown below :—

	Expanse in mm.	Normal expanse.
Byasa varuna astorion, Wd. ♂ ...	80	88-136
,, aristolochiæ, F. 2	72	76-114
Papilio demoleus, L.	64	80-100
Delias eucharis, Drury ♀	58	80-85
Catopsilia byranthe minna, Herbst ♂ ...	44	50-70
Danais chrysippus, L. ♂	58	70-80
,, plexippus, L. ♀	62	75-95
Charaxes polyxena imna, But. ♂ ...	68	90-100
Eribœa athamas agrarius, Swin. ...	50	60-75
Precis orithya swinhœi, But. ...	36	40-55
Hypolimnas bolina, L. ♂	66	70-110
Cethosia cyane, Drury ♂	64	85-95

These are all Sambalpur captures, except the first (from Sikkim) and the last (from Burma). None of them shows any marked peculiarity except the *Charaxes*. It bears tawny spots in interspaces 1 and 2 on the black border on the forewing. Evans, in his *Identification of Indian Butterflies,* says this is a feature of the dry season form, but none of my dry season captures of normal-sized *imna* shows this feature. Moreover this dwarf specimen was caught in July, i.e., in the wet season.

It would be interesting to know if these dwarf specimens are common.

BELFAST,
June 26, 1929.

W. M. CRAWFORD,
F.E.S.

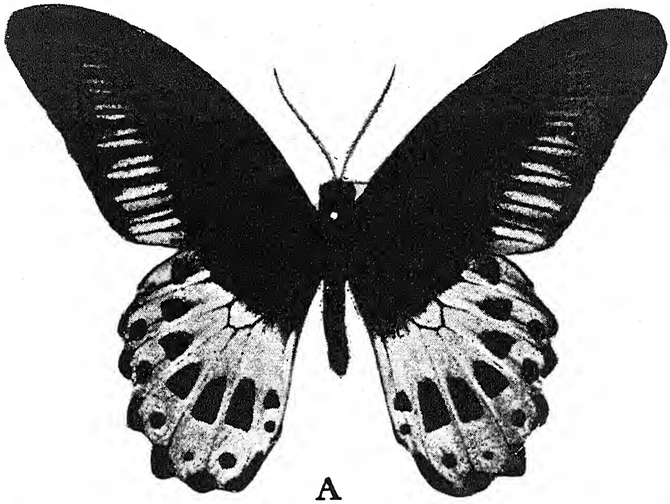
XXIX.—THE LIFE HISTORY OF THE SILK-MOTH (*LŒPA NEWARA* [MOORE])

For a description of this rare and beautiful silk-moth I would refer the reader to *Fauna of British India, Moths,* by Sir Geo. F. Hampson. (Bart.), Vol. I, p. 26, n. 27. (1892).

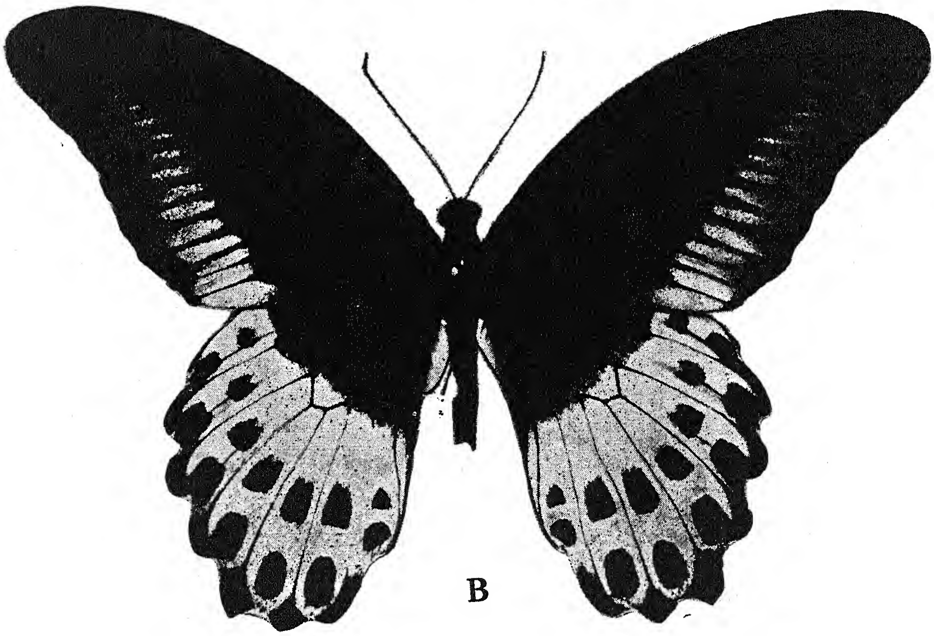
From a study of this, and the habitat recorded, viz.—Nepal, and Sikkim, it will show that the Northern Shan Hills is a new locality for this species.

LARVA :—rough, rather bright green, of a peculiar bulgy shape, and of a somewhat flattened appearance resembling the shape of a narrow lanceolate leaf, head small; it is entirely devoid of large tubercles.

Length.—(full-fed) 75 mm.



A



B

A—DWARF EXAMPLE OF PAPILIO POLYMNESTOR
B—NORMAL EXAMPLE OF PAPILIO POLYMNESTOR

Months of appearance.—March and April.

Food Plants.—*Cæsalpinia nuga.* (Ait.) A tree; stalks of the leaves thorny. (Burmese name.—Soo-gouk.)

PUPA :—enclosed in a strongly woven and compact, dull bluish-green cocoon, which is very neatly and strongly attached to a twig of its food-plant by a silken appendage. Dark brown in colour, and closely resembling the shape of the chrysalis of *Attacus atlas* (Linné.) but smaller. The cocoon has a wide mouth or opening at the top like that of a jug, with its two sides tightly closed.

Months of pupation.—April to January.

Situation.—Enclosed in a dull bluish-green cocoon which is attached to a twig of its food-plant and suspended by a silken appendage.

IMAGO :—emerged in January. It therefore remains eight to nine months in the pupa state.

Habitat.—Nepal, Sikkim, N. E. Himalayas; Northern Shan Hills, N. E. Burma.

Localities.—Darjeeling, Sikkim; Maymyo, N. Shan Hills.

Elevation.—(altitudinal range) 3,500 to 7,000 ft.

Months of appearance.—January and February. (This refers to the Shan States.)

Comparative abundance.—Rare.

Expanse.—♂ 132 to 150 mm. ♀ 142 to 150 mm.

It may also interest Lepidopterists to know that I captured a ♀ of *Lœpa katinka* (Westw.) at Maymo, Northern Shan Hills, elevation, 3,500 ft. in September, at light. This is the first observation recorded of its occurrence in Burma.

It seems strange that the larva of *L. katinka* is hairy according to Hampson (vide *Fauna Brit. Ind., Moths, I, pp. 25, 26; n. 25*) (1892) and is also adorned with 'six pink tubercles on each somite'; and with 'white sublateral irregular blotches from 4th to 10th sometimes, claspers pink' while that of *L. newara* (Moore) is simply rough skinned, and is the same uniform colour all over. Surely the characters in the larvæ of species belonging to the same Genus would be, at least, somewhat similar in general appearance, but there would seem to be a vast difference between these two species. I would be glad if any Lepidopterist will corroborate Hampson's description of the larva of the former species, and let me know.

PEGU, C. E. FELLOWES-MANSON.
BURMA,
June 1, 1929.

XXX.—THE HUMAN EAR USED AS A BURROW BY A SPHEGID WASP

A British soldier recently reported to my father an account of deafness and, on sryinging out his ear, portions of a small wasp and larvæ were found amongst other debris.

The onset of the complaint had been sudden, the condition of the ear was normal except for rather an excess of wax.

Being rather busy at the time, my father asked me to send these abnormal residents of the ear on to you for opinion.

The result has been as follows :—

Dr. Hem Singh Pruthi, of the Zoological Survey of India, very kindly wrote the following,

'In reference to your letter, dated 24th of August 1929, addressed to Dr. Prashad, I have to inform you that the larvæ are of Lepidoptera, whereas the adult insect (broken in pieces) is a *Sphegid* (Hymenoptera), probably belonging to the genus *Gorytes*.

'Sphegids prey on many insects, including Lepidopterous larvæ, which they paralyse by stinging, subsequently storing them in suitable burrows for their young ones to feed on. In the case under reference, it appears that the wasp mistook the ear of the patient for a burrow in a wall. If so, he must sleep very soundly indeed!

'(Sd.) Hem Singh Pruthi, Assistant Superintendent, Zoological Survey of India.'

Foreign bodies in the ear are of interest to many; in this case it seems lucky that the man awoke when he did; otherwise, he might have found a hymenopterous family inhabiting his ear, the buzzing of which would have been even more intense than that described by Dr. Oliver Wendle Holmes in his 'Stethescope Song'.

Further research into the aural contents of those working in some official offices might lead to more interesting finds, perhaps spiders to catch the daring hymenopteron or even 'bats'.

Hoping that the above short notes may prove of interest to readers of the Journal.

FEROZEPORE, LORNA BOYD.
September 13, 1929.

XXXI.—NOTES ON THE FLOWERING OF *STROBILANTHUS CALLOSUS*, NEES

The flowering period of this *Strobilanthus* has led to much discussion and conjecture. Some of the standard works give the flowering of this species as occurring at intervals of seven, eight and even as much as twelve years. The local people who use this plant for various purposes tell me that it flowers every three years but this I do not accept as true, as such statements are very often based on no sound foundation.

It is not with a view to clearing up these differences that I write these notes, but only as a record, which in time will no doubt help in throwing some light on the subject.

In Salsette, among the hills around the Kanari Caves, flowers appeared on isolated plants in August-September 1927. In the following year (1928) in August and September, there was a general flowering throughout the area. Those of the previous year seem to have foreshadowed the coming event. In March of 1929, all that was left were the tall stems (some of which were twelve feet

in height) with all the fruit still attached to them. The peculiar musky smell was very strong throughout the area.

In September (1929), when I visited the area again, no tall specimens were to be seen with the exception of a few isolated plants, here and there but by no means numerous. In the place of the old plants a large number of seedlings had sprung up, which did not exceed two-foot-six in height. The forests appeared very naked without their usual complement of tall *Strobilanthus*, which was very striking indeed.

This record will enable someone in the future to clear up this point.

BOMBAY NATURAL HISTORY SOCIETY, C. McCANN.
BOMBAY,
September 19, 1929.

XXXII.—SOME NOTES ON SCORPIONS IN IRAQ

That scorpions are an ancient affliction of Iraq is attested by a recent find of Mr. C. L. Woolley's at Ur of the Chaldees. From the King's Grave was taken, amongst other things, a harp, the standard of which was made in the likeness of the fore-part of a bull. Between his legs are four decorative shell plaques; the lowest bears a representation of a creature with the head of a man on the body of a scorpion. The terminal segments are arched as locally reputed to be in the commoner varieties of scorpions only.

To-day as probably then, scorpions are found throughout the length and breadth of Iraq. Sulaimania is said to have its own peculiar variety and Mandali, Dohuk and Mungash all enjoy or rather suffer reputations in respect of ultra-venomous scorpion populations.

From Mandali, I was recently sent four small yellow scorpions with notes to the effect that these were of a variety peculiar to Mandali, were very venomous, and were known as 'jerrar' on account of their habit of carrying the 'tail' trailing, not arched. It was further stated that few bitten by them recovered and that four people had already died in the town of Mandali up to the end of September, in 1929. These deaths have not been authenticated.

A short while ago I was touring in the Dohuk area, north of Mosul, and made continual enquiries about scorpions from the natives. The invariable opinion was that they were common; one tribesman volunteered the information that the yellow scorpions were to be found in the open and the black ones under cover in buildings, ruins, etc.

In Dohuk itself, the town fathers, that is the Rais Baladiyah, the Qaim Maqam, the doctor, the school-master and one or two other notables seated in conclave, gave the following information:—

Scorpions abound in all villages but are more dangerous in some than others, also in any one village, in certain parts they will

be more venomous than in certain other parts of the same village. They had no explanation to offer for this.

The black scorpions are more to be feared and drag their tails being consequently known as 'jerrar'. Reversely the yellow scorpions are not so poisonous and do not drag their tails.

In Dohuk, for the last twenty years, deaths from scorpion's bite have averaged one a year. Children, mostly under ten, have supplied the victims. They stated that if a child had been stung by a scorpion and was going to die loss of speech followed by death in three hours was the rule. *Apropos* of this, a local shop-keeper was sent for. He had witnessed the death of a boy of ten about three months before. The child himself said that it was a scorpion that stung him on the left second toe; this occurred at night. He developed a very cold sweat, an incoherence of speech, spasm of the hand muscles, suggestive from the description, of 'accoucheur's hand' and died in five hours.

A Dr. Sati who has been very many years a practitioner in Mosul and who has always had an interest in snakes and scorpions, contributes the following items from his own observation and opinions :—The black tail-dragging sort is known as 'jerrar' and is dangerous, the yellow tail-arching sort less so. The sting is more dangerous when applied in dorsi-flexion than when it is applied in extension. (This may have some relationship to the differences in degrees of pressure exerted on the poison glands in flexion and extension). Scorpions are attracted by chamomile herb. He kept a black scorpion in a glass in the light for twenty days, at the end of which time the scorpion was yellow.

In Baghdad at the present time the simpler townsfolk place scorpions in bottles and state that they then exude an oil which is curative for their stings. They are said to be blind and to be responsible for the holes that duly appear in metal domestic vessels and containers. One hears of a certain number of scorpion stings in Baghdad every year; I have, however, yet to hear of any serious results from stings in Baghdad.

The Dohuk and Mandali fatalities quoted above, I am on the whole inclined to credit.

A few simple experiments will obviously separate much of the preceding hearsay into fact and fable and one hopes to carry them out some time.

In the meanwhile, these notes are forwarded in view of scorpions being topical for the moment from the B.N.H.S. point of view.

ROYAL COLLEGE OF MEDICINE, NORMAN L. CORKILL.
BAGHDAD,
October 12, 1929.

[Dr. Corkill has sent us for identification two species of scorpions. One, common about Baghdad houses, is *Hemiscorpiops lepturus;* the second is the much dreaded 'jerrar' variety from Mandali, to which reference is made in Dr. Corkill's note. The species in question is *Buthus australis,* the toxicity of whose venom is comparable to that of the Cobra.—EDS.]

XXXIII.—SWARMING OF THE TENEBRIONID BEETLE (*LYPROPS CURTICOLLIS*, FAIRM)

I shall thank you to let me know the name and all particulars about the life-history and habits of the enclosed insect, known amongst the Cochin planters as 'Mooply Beetle', because it appears to flourish abundantly in the Mooply valley.

I have been informed that the beetle does not attack India-rubber or other plants, but comes into houses in countless millions, covering ceilings, pictures, tables, in fact, settling upon everything; and on this account, it has become a terrible domestic nuisance, so much so, that it is believed that some of the villages in that district have been deserted owing to the invasion by these beetles. No one seems to know where they breed and what they live upon; and drenching them with kerosene oil, and setting fire afterwards, does not seem to have any effect in diminishing their numbers.

I shall feel obliged if you will kindly let me know all about these pests, and the measures to be adopted for their destruction and prevention. This beetle is not met with in Kodaikanal.

'IFFLEY,'
KODAIKANAL, S.I.,
September 22, 1929.

D. A. TURKHUD,
M.B., C.M. (Edin.)

[The Beetle in question has been identified at the British Museum as *Lyprops curticollis* Fairm. Mr. Frederick Laing of the Entomological Department writes:—'The beetle is *Lyprops curticollis* Fairm., my colleague Mr. K. G. Blair tells me. I have searched through our own index here and various other works of reference, but I have failed to find any mention of the life history.

Failing the discovery of where the beetle is breeding, the only suggestion I can make is that trial might be made with one of the sprays now on the market—something after the style of "Flit". Most of these sprays consist essentially of a petrol or paraffin in which is dissolved pyrethrum extract; other substances, such as camphor, may be aded. Several of these sprays will destroy crickets and would also kill this beetle probably.' Writing subsequent to the receipt of this information Dr. Turkhud tells us that 'Flit' had been tried against these beetles without any helpful results.—EDS.]

PROCEEDINGS

A meeting of members of the Bombay Natural History Society and their friends was held at the Prince of Wales' Museum on Thursday, November 28, 1929. Mr. H. A. W. Brent was in the Chair.

The Honorary Secretary, Sir Reginald Spence, announced the election of the following forty-one members since the last meeting held on July 23, 1929 :—

Major J. B. Hance, O.B.E., I.M.S., Bombay ; Capt. N. M. Hughes-Hallet, Razmak ; Lt.-Col. M. A. Nicholson, I.M.S., Abbottabad ; Major E. E. Doyle, I.M.S., Poona ; Capt. G. F. Heaney, R.E., Maymyo, Burma ; J. A. Thorne, Esq., I.C.S., Tanjore, S.I. ; Roderick Dobson, Esq., Talawakelle, Ceylon ; J. L. F. Purvis, Esq., Mergui, Burma ; J. W. Landells, Esq., Mergui, Burma ; The Hon'ble Mr. Ernest Burdon, C.S.I., C.I.E., I.C.S., Simla ; Sri Balvadra N.B. Deo, Raja and Ruling Chief of Keonjhar State ; Dr. J. Loudon, M.B., Panerihat, Assam ; H. H. Rai Rayan Maharajadhiraj Maharawal Shri Lakshman Singhji Bahadur of Dungarpur ; Alphonse M. Als, Esq., Bombay ; B. S. Thomas, Esq., Muscat, Persian Gulf ; W. E. Bell, Esq., Mergui, Burma ; T. G. B. Davies, Esq., Khaur, Punjab ; H. Beresford-Berrett, Esq., I.F.S., Bassein, Burma ; C. B. Sethna, Esq., Bombay ; Raja Bhavani Shankar Sekhar Deo, Raja and Ruling Chief of Gangpur State ; G. L. Winterbotham, Esq., M.L.C., Bombay ; T. R. Paterson, Esq., Jalpaiguri ; E. E. Ranicar, Esq., Valparai, S. I. ; J. R. Belmont, Esq., Bombay ; H. L. Aspden, Esq., Bombay ; Alfred Ezra, Esq., O.B.E., F.Z.S., Surrey, England ; The Head Master, Govt. English School, Virajpet, Coorg ; R. W. Inder, Esq., I.F.S., Karachi ; C. K. Bridgmell, Esq., Rajmai, Assam ; J. M. Stapylton, Esq., Mandla, C. P. ; K. Lindberg, Esq., Sholapur ; E. W. Grennan, Esq., Belgaum ; A. H. Cook, Esq., Edinburgh, Scotland ; Capt. N. J. G. Jones, Miranshah, N.W.F.P ; J. E. Liberherr, Esq., Bombay ; Mrs. L. J. Peck, Delhi ; C. C. Inglis, Esq., Poona ; Jehangir Dinshaw Davar, Esq., Bar-at-Law, Bombay ; A. D. F. Dundas, Esq., I.C.S., Miranshah, N.W.F.P ; The Secretary, Imperial Council of Agricultural Research, Delhi ; Capt. H. Puckle, Ambala, Punjab.

Sir Reginald Spence, the Honorary Secretary, outlined the progress in the plans for the building of a new Natural History Wing to the Prince of Wales' Museum. The development and growth of the various sections now represented in the museum made the question of additional space urgent and imperative. The Trustees had approved of a scheme for building a new wing to form the Natural History Museum and were prepared to provide the sum of 2 lakhs towards the cost of the new building which was estimated to cost 5½ lakhs. His Excellency the Viceroy had very kindly agreed to lay the foundation-stone of the new wing, provided we could furnish the assurance that work on the building would commence next year. The Trustees of the Museum and the Society were therefore faced with the necessity of raising about 3½ lakhs of rupees. The Society had already made appeals to various Princes and private citizens and Sir Reginald was glad to announce that he had received a donation of Rs. 5,000 from the Bhavnagar Durbar for the building fund. He hoped that further donations would help the Trustees to realize their plan of providing Bombay with a first class Natural History Museum.[1]

A Giant Perch from Bombay Harbour.

An interesting recent addition to the Museum is an example of an enormous Leopard Perch (*Serranus pantherinus*), presented by Mr. Yusuf Hasham. The fish measured a little over 7 feet in length and scaled 475 lbs. It was caught by local fishermen on a night line in Bombay harbour. The specimen has been beautifully mounted. It will indicate to local anglers the variety of sea fishing in Bombay.

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[1] H. E. The Viceroy was unable to lay the foundation-stone owing to our being unable to furnish the required assurance.

THE SOCIAL LIFE OF ANTS.

Mr. S. H. Prater, the Society's Curator, delivered a lecture on the Social Life of Ants. Man, the highest of the social animals, cannot fail to be interested in the strange resemblances to human society revealed in the communal lives of Bees, Wasps, Ants and Termites. They are truly social insects. The occupants of a wasps' nest, the inhabitants of a hive, a colony of ants or the dwellers in a termite mound, no matter how populous, represent an assemblage of parents and offspring. These teeming families often contain a single parent—the mother or Queen—with her brood. The progeny are not only protected and fed by the mother but they eventually co-operate in protecting and feeding her and become nurses to her subsequent broods. The lecturer outlined the various methods followed by ants in founding new colonies Flights of winged ants which are a familiar feature at certain seasons of the year herald the establishment of new colonies. This brief aerial adventure is the occasion when the males mate with the virgin Queens—the future mothers of the colony.

Whether in Man or in Insects communal life is established because the individual benefits by a life in common with his kind. The individual produces more than he consumes; the community as a whole reap the benefit. One direct result of social life is over-production and over-accumulation. Man not only accumulates material objects but he accumulates manners, rites, beliefs and superstitions—the product of his social life. Overwhelmed under the crust of these social deposits, which gather volume and sanctity with age, he is compelled periodically to break through. He seeks relief in war or in revolution. Germany, auto-intoxicated with her special brand of 'Kultur', seeking an outlet for her enormous productions, plunges into war in her quest for a place in the sun. The masses in Russia, ground under the yoke of social inheritances, of prejudices, traditions and habits of life accumulated through the long ages of its history, break through their trammels in red revolution. Insects manage the same problem somewhat better. When a colony reaches the acme of its accumulation, when its territory is no longer able to support its members, it sends forth fresh young members to found new colonies. The elders are effaced and the parent colony succumbs with true humility and good cosmic manners.

With the majority of ants the male dies after mating with the Queen. The purpose of his life accomplished, he is of no further use to his community. The continued fertility of the Queen is established by a single act of mating. She continues to produce eggs for the rest of her life. The majority of her offspring are thus condemned to a life of celibacy. They are workers pure and simple. They form a sterile proletariat destined to a life of unremitting toil. They must build and defend the nest and provide food and accommodation for the Queen, for themselves and the young. In some prolific colonies the labour is so exacting that a special caste of soldiers is developed to take over the defence of the community.

Like man, ants have passed through different degrees or stages of civilization. They have passed from the nomad and hunting stages to the pastoral and finally to the agricultural and industrial stage.

Thus we have the Hunting ants represented in various species of the family *Poneridæ*. They live by raiding and ravaging the nests of termites and of other ants.

The large black ant of our bungalows and the fierce red tree ants which build nests of leaves are in the pastoral stage. They go in largely for keeping 'cattle' and living on dairy produce. Various insects act as ant 'cows'. They provide the ants with a sweet nectar which exudes from their bodies and in turn are kept and cared for by the ants. Our harvesting ants—one can always tell their nests by the ring of chaff piled round the entrance—have reached the industrial and agricultural stage; they build roads through their properties and maintain granaries where they store the grain and seeds they gather.

A hearty vote of thanks was unanimously passed to the lecturer by the meeting which was the largest for many years.

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ERRATA

ANTS AND THE LAC INSECT

The Editors regret that the following printing mistakes have occurred in the above article in the last issue of the Journal, viz. No. 1 Vol. XXXIV :—

Page 184 line 24 for *Netaceous* read *Testaceous.*
Page 186 line 6 for ' strenth ' read ' strength '
Page 186 line 10 insert after ' takes '

' hours to kill it, but does not dare to approach a healthy uninjured ' . . . . (line 11)

Page 187 line 29 insert after ' catch '

' Small birds. With mixtures of the latex of the above Ficus ' . . . . (line 31)

Line 30 must be omitted.

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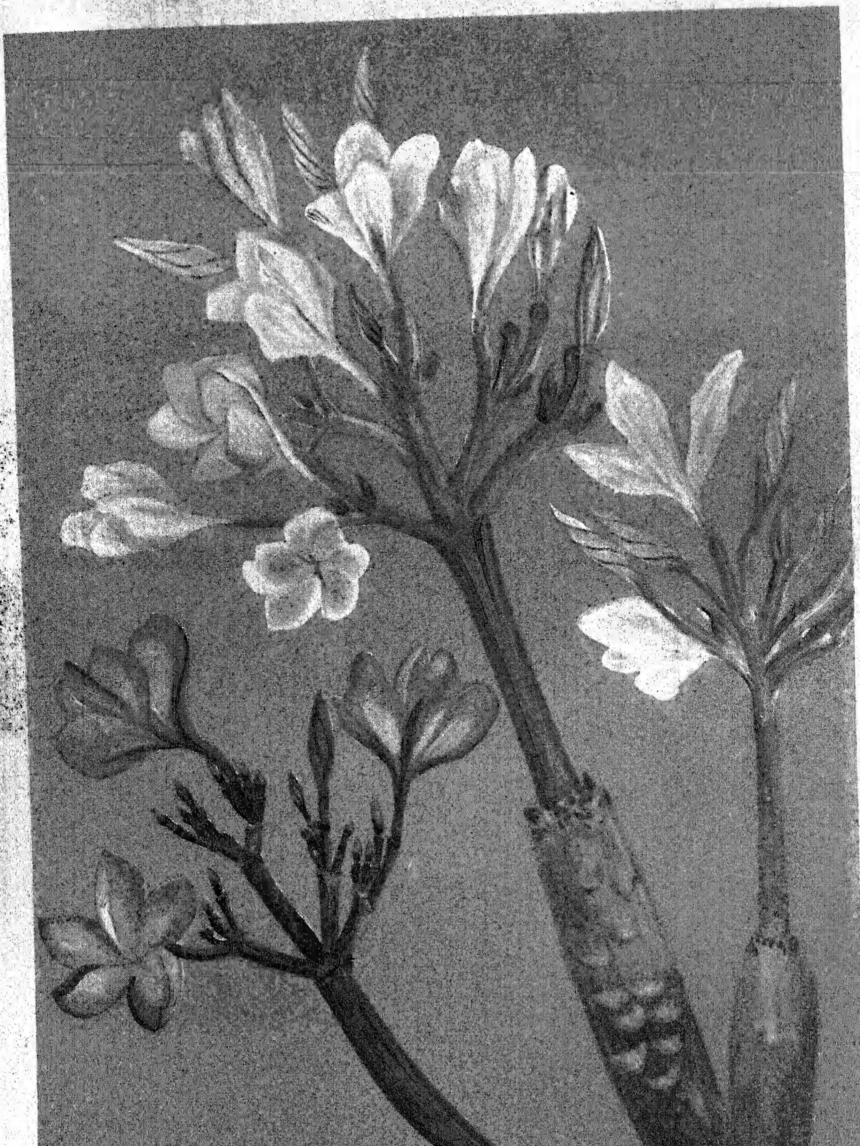

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THE PAGODA TREE.
Plumieria acutifolia, Poir (Right.)
FRANGIPANI.
Plumieria rubra, Linn. (Left.)
(2/3 nat. size.)

JOURNAL
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JULY, 1930 VOL. XXXIV No. 2

SOME BEAUTIFUL INDIAN TREES.

BY

E. BLATTER, S.J., PH.D., F.L.S. AND W. S. MILLARD, F.Z.S.

PART IV.—(*With two coloured plates, two black and white plates and four diagrams.*)

(*Continued from page 86 of this volume.*)

THE PAGODA TREE

Popular names : Pagoda Tree, Temple Flower, Graveyard Flower, Dead Man's Flower, Spanish Jasmine, Frangipani, Flor de St. Antonio; Kishira-champa (Sans.); Gul-e-chin (Hind.); Khair-champa, Khera-chapha, Sufed-champa (Mar.); Dolo-champa (Guz.); Goalanchi (Ass.); Gorur-champa (Beng.); Gangala (Kan.); Vada-ganeru (Tel.); Champa-pungar, Gulanj-baha (Santal); Tayop-sa-gah, China champac (Burm.); Alariya (Ceylon).

Plumieria acutifolia, Poir. Encl. II (1811), 667.

The generic name *Plumieria* is after the Franciscan traveller and distinguished French botanist, Charles Plumier (1664-1706); *acutifolia* describes the pointed or tapering leaves. The genus *Plumieria* is included in the family *Apocynaceæ,* the Dogbanes.

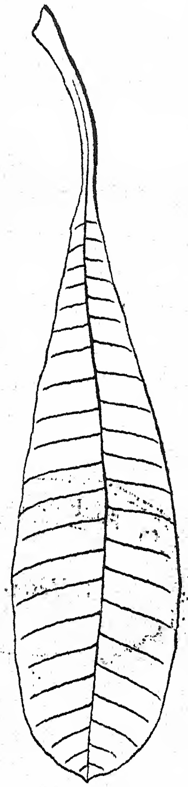
This is the tree so frequently cultivated in the neighbourhood of temples where it supplies the continuous demand for flowers used as votive offerings to the gods. Its remarkable power of bursting into leaf and blooming even when taken out of the soil have led it to be regarded as an emblem of immortality. As such its frequent presence in graveyards is not altogether inappropriate. The author of the *Cruise of the Marchesa* refers to the Dead Man's Flower dropping its deliciously fragrant blossoms over the quaint tombs of the Sulu islanders. Writing of this tree he says 'Buddhist and Mahommedan alike plant the Champac above their dead. So should we, I think, did our climate permit it. Day after day throughout the year, the tree blooms. Day after day the delicately creamy corollas fall upon the graves retaining both their freshness and their fragrance unlike any other flower.'

Description : The Pagoda Tree grows from 15-20 feet in height. Its grey-coloured bark is rough and scaly. On injury, the inner bark and every part of the tree exudes a copious flow of a white and

NOTE.

Mr. Stuart Baker's serial on Indian Game Birds was not received in time for issue with this number. It will be resumed in the next.

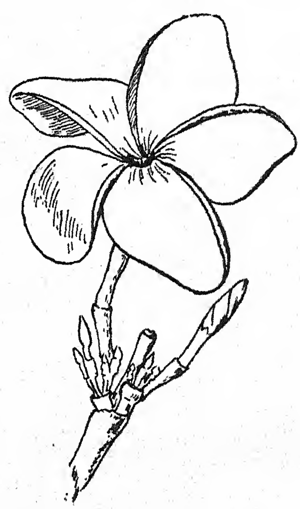
viscid juice, hence its Sanskrit name, *Kishira-champa* meaning 'Milky Champa'. The leaves grow in crowded spirals at the tips of the branches. The leaf is slightly over a foot in length. It is smooth, broadly lance-shaped and tapers at both ends. Very distinctive are the straight, parallel veins which run from the midrib to the margin of the leaf, where they are absorbed in a waved vein which runs along its borders. The Pagoda Tree sheds its leaves during November and December and does not renew them till the commencement of the rains. Young trees remain in leaf through the year. In full leaf, the tree is not without elegance but stripped of its handsome foliage, its crooked trunk and the grotesque outlines of its blunt and swollen branches give it an uncouth and gouty appearance. The flowers grow in upright clusters at the tips of the branches. In well-cultivated trees the clusters are large and contain quite as many as twenty blooms. The large, waxy white flower has a distinctive golden centre. It is funnel-shaped with five spreading petals, faintly tinged with pink below. The left margin of each petal has a tendency to curl over. The stamens are inserted deep within the tube of the flower. They are not visible externally. These are perhaps amongst the most fragrant of tropical flowers. They distil, particularly at night, a perfume which is almost overpowering.



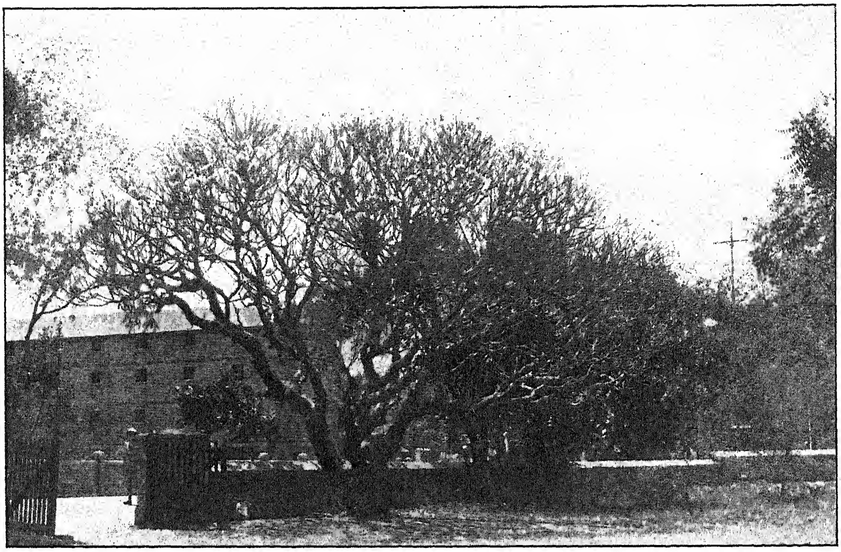
Flowering Season: February to October; practically throughout the year.

The fruit is a pod about 5 inches long. The Pagoda Tree rarely seeds in this country.

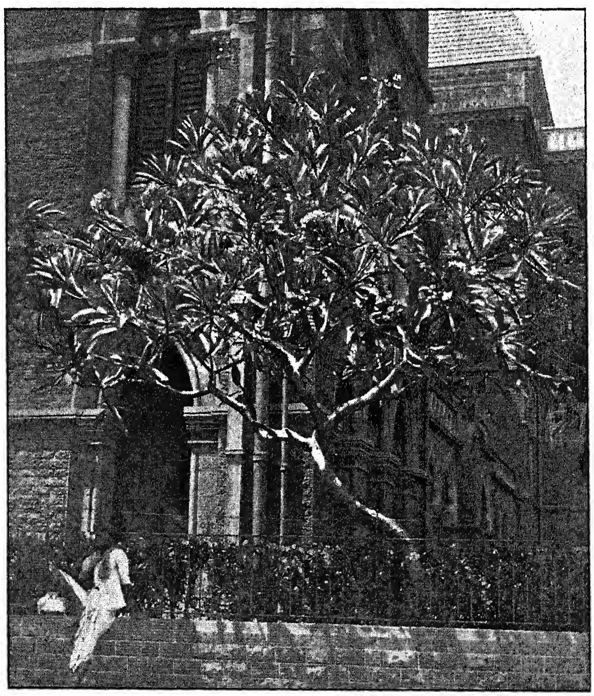
Variety: There is a handsome variety occasionally seen in gardens. The buds are a deep, glossy crimson. When fully open half the underside of each petal is a dull crimson, the other half creamy white. The curling edge of the petal displays a beautiful, crimson margin and the throat of the flower is more vividly golden than in the commoner variety.



Distribution: A native of Mexico and Guatemala, the Pagoda Tree is believed by some writers, though wrongly, to be indigenous in China and Cambodia. Rhumphius, who first described the tree under the name *Flos convolutus*, says it was brought to Amboyna by Chinese merchants from Cambodia. Its Hindustani name, *Gul-e-chin*, meaning 'Flower of China' and the Burmese name, *China-champac* rather suggest a similar origin



The Pagoda Tree (*Plumieria acutifolia*) leafless and in flower; March.



The Frangipani (*Plumieria rubra*) in full leaf and flower; March.

in India, where the tree has been cultivated from time immemorial. In 1770 it was introduced into England as a hot-house plant from the East Indies.

Gardening : The tree is propagated by cuttings which should be allowed to wilt before planting. At first they should not be kept too moist. The hot season is the best time for planting. During the cold weather large specimens may be transplanted without the accompanying soil.

Uses : Attempts to manufacture caoutchouc from the viscid juice of this tree have been without success. The sap is employed with sandal-wood oil and camphor to cure itch, and is used as a counter irritant to cure rheumatic pains.

The bark, known as *A'chin* is recommended by the Persians as a cure for gonorrhea and venereal sores. It is used for a similar purpose in Porto Rico. In Bombay it is used for intermittent fevers as we use Cinchona. In the Konkan, it is given with coconut, ghee and rice as a remedy for diarrhoea. A decoction from the bark makes a powerful anti-herpetic. Its use as a purgative is not without danger. Several cases of death from excessive purging after its use have been recorded. Plasters made from the bark are said to be useful in dispersing hard tumours.

The leaves, after being heated, are applied as a poultice to reduce swellings. In Gōa the leaves and branches are tied round coconut palms to protect them against the attacks of the Long-horned Beetle (*Batocera rubra*).

The flower buds are taken with betel leaves as a febrifuge. The seeds, when available, are boiled in milk and given as an antidote in cases of snakebite. Mr. Millard once had a few seed-pods on one of the trees in his garden in Bombay and his Mahratta *malis* expressed the belief that the seeds were eaten by cobras. The seeds certainly disappeared but he has his suspicion that the *malis* were in league with the cobras.

FRANGIPANI

Popular names : Frangipani, Frangipanie Rouge, Red Jasmine; Lal-champa (Mar.).

Plumieria rubra, Linn. Sp. Pl. 209.

On Plate VII, our artist has included a flowering branch of the Frangipani, a different tree of the same genus. Frangipani is supposed to be derived from the French, *Frangipanier,* which means coagulated milk, referring to the tenacious white juice, characteristic of trees of this genus. Other accounts suppose it to have come from an Italian nobleman of that name who, in the Middle Ages, compounded a perfume of many ingredients which had an odour similar to these flowers.

Description : Smaller than the Pagoda tree, the Frangipani grows to a height of 12 to 20 feet. With its beautiful red flowers and handsome foliage it is especially ornamental. The leaves are smaller than those of the Pagoda Tree, being from 5 to 8 inches long. The flowers grow in crowded clusters on downy, red stalks. The petals are red, centred with rich yellow. They are broadly oval in shape and rounded at the apex. The flowers have a pleasant

scent which is not so overpowering as in the Pagoda Tree. In South America, women adorn themselves with these flowers and put them among linen to scent it as we do with lavender.

Distribution: The native home of the Frangipani extends from Mexico to Guiana and Ecuador.

WHITE FRANGIPANI

Plumieria alba, Linn. Sp. Pl. 210.

Another species of *Plumieria* which is not so common is the White Frangipani, *Plumieria alba.* It is a native of the West Indies, as of Jamaica, Martinique and the mainland of South America. The tree is about 15 feet in height. Its rigid brittle leaves are rounded at the apex. They are smooth above, hairy beneath and curl inwards at the margins. As with *Plumieria rubra,* the tree remains in leaf through the cold and hot weather. The flowers are white without the yellow throat. The tree is called Frangipanie Blanc by the French in Martinique.

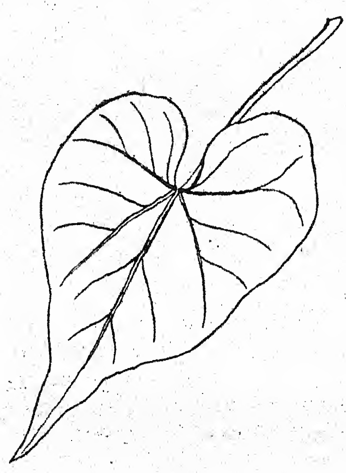
THE BHENDI TREE

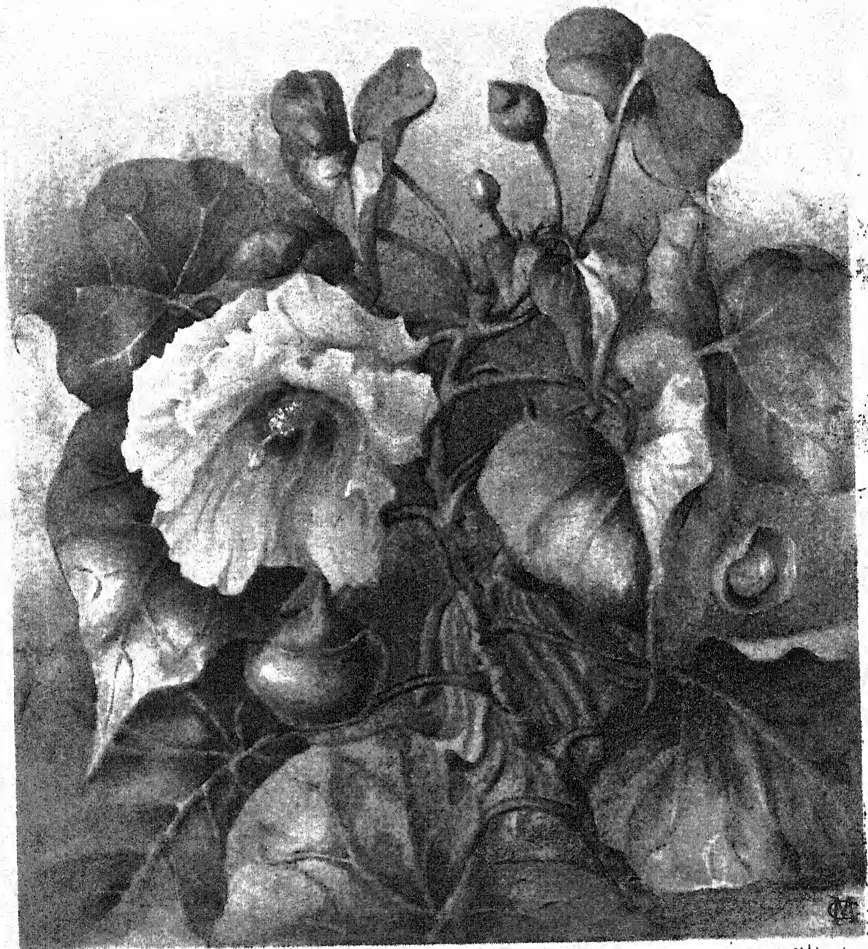
Popular names: Bhendi Tree, Tulip Tree, Portia Tree, Umbrella Tree; Parisa (Sans.); Parascha Jhada (Hind.); Poresh, Dumbla (Bengal); Bhenda or Bhindi (Mar.); Huvarasi (Kan.); Gangareni (Tel.); Portia, Pursa, Puvarasam (Tam.); Parascha-Pipla (Guz.); Vhadli Khari kapusi (Konk.).

Thespesia populnea, Corr. in Ann. Mus. IX (1807), 290.

The generic name is derived from *Thespesios,* divine, in allusion to its being frequently planted near churches. Although often grown in the compounds of temples, particularly in South India, the name is hardly appropriate so far as India is concerned. The similarity of the Bhendi's leaves to the Poplar is signified in the term *populneus.*

Description: The tree reaches a height of 30 to 50 feet. Its smooth grey trunk is tall and straight. Its numerous branches form a heavy spreading crown of close set foliage. The broad, heart-shaped leaves grow alternately about the ends of the branches. A single leaf is from 3-6 inches long. It has a fine tapering point, much like the leaf of our Pepul or of the Poplar. It is smooth, has a close net-work of fine veins and from 5 to 7 prominent veins which radiate outwards from the base of the mid-rib. One or at times, both sides of the leaf bear a few minute, ash-coloured scales, each carrying a dark central spot. The Bhendi is evergreen, its change of leaf is gradual but is particularly marked in February when many of the old





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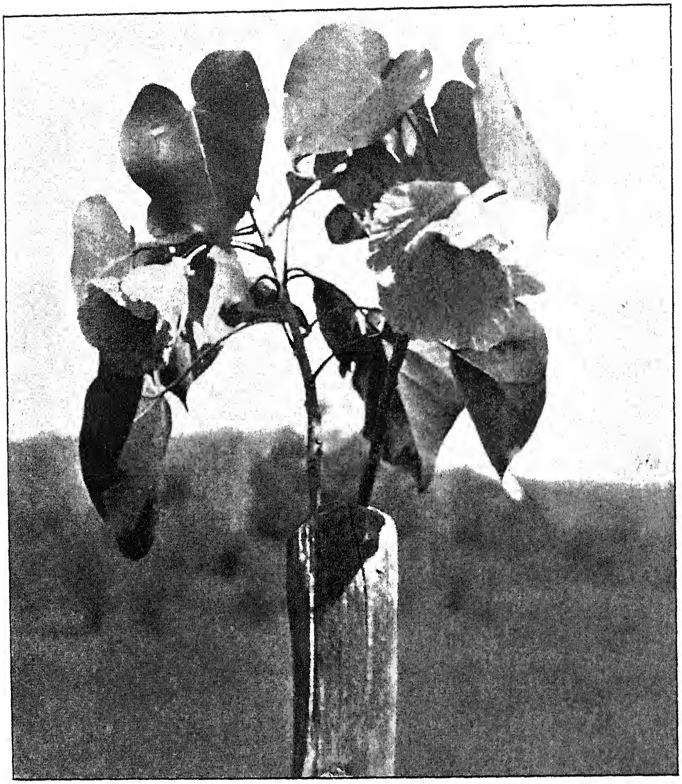
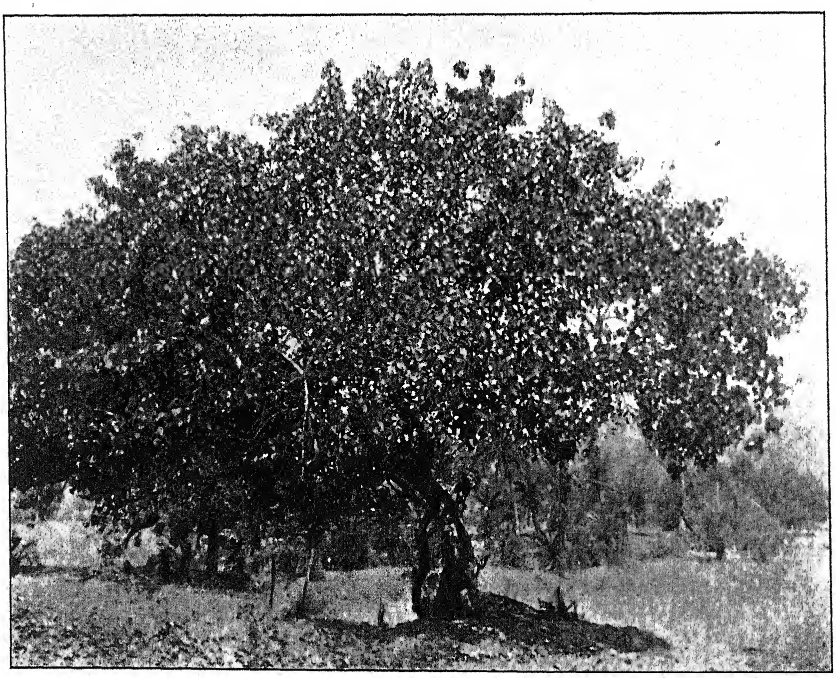
THE BHENDI TREE.
Thespesia populnea, Corr.
(2/3 nat. size.)

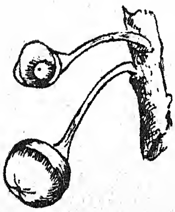


Flowers of the Bhendi Tree (*Thespesia populnea*).



The Bhendi Tree (*Thespesia populnea*).

leaves turn bright yellow and at a distance give the tree an appearance of being in bloom. The flowers are from 3-4 inches across. They grow singly or in pairs. The pale lemon-yellow blooms with a deep maroon centre are very beautiful. When withering they fade gradually from salmon pink to a dull purple. The petals are finely crinkled and are set in a cup-like calyx. The long style grows through a tube, decked with a cluster of golden-headed stamens. It is crowned with a club formed of five close-set stigmas. The globular turban-shaped fruit is cupped at its base in the calyx which persists after the petals have fallen. It contains five cells, each packed with from one to three, down-covered, egg-shaped seeds. The fruits are green at first but turn brown and then black with age. They remain for a long time on the tree. The flower and fruit have the aspect of the *Hibiscus* in which genus of plants the Bhendi was formerly included. But the close-set stigmas, the woody character of the fruit and the flat, egg-shaped seeds are distinctive characters in *Thespesia populnea.*



Flowering season : The tree flowers throughout the year but particularly at the beginning of the cold season.

Distribution : It grows wild along the beach and tidal forests of our west coast from the Konkan southwards, coasts of Chittagong and the Andamans. Littoral throughout the tropics.

Gardening : The Bhendi is a common roadside tree on the Bombay side of India. It prefers a light porous soil and is easily raised from seed or cuttings and grows quickly. When grown from cuttings, as most trees appear to be, they are crooked and distorted but the handsome heart-shaped leaves and large tulip-like flowers make this tree very noticeable.

Uses : The tree is valued for its tough, fine-grained timber which is used for the manufacture of gun-stocks, cartwheels and, because of its resistance to water, in boat-building. The bark yields a fine tough fibre which appears to be rarely employed. Both the bark and the heart-wood contain tanin and a fine red colouring matter. The deep red heart-wood is spoken of as a remedy in heart attacks and in a kind of Pleurodynia which is prevalent among the Malays. The flowers and fruit yield a yellow dye not unlike gamboge. The viscid, yellow juice with which the fruit abounds is also used as an external application in scabies and other cutaneous diseases. Experiment has however shown that in most instances it produced little or no benefit. The leaves are applied as poultices to swellings, sores and abscesses. A decoction of the bark is used as a wash for skin diseases and is given internally as an alterative.

(*To be continued*)

THE STUDY OF INDIAN BIRDS.

BY

HUGH WHISTLER, F.Z.S., M.B.O.U.

PART V

(With 1 plate and 6 text figures.)

(Continued from page 39 of this volume.)

SOME EXTERNAL CHARACTERISTICS OF A BIRD.

The Foot

The structure of the foot of a bird and the relationship of its parts with the corresponding limbs of the reptile and the mammal have already been described in Part I at page 168, Vol. XXXI of the *Journal*, with a plate showing the various bones. It must be remembered that modifications of the hind limb tend necessarily to be correlated with modifications of the pelvic girdle on which the hind limb works. As, however, the various modifications of the pelvic girdle are rather technical to describe and their meaning and connection with the developments of the leg are not fully understood, they need not be discussed here.

Brief mention must be made of two points, the ambiens muscle and the tendons of the foot. The ambiens muscle is peculiar to birds and reptiles and is found in neither mammals nor amphibians. It originates on the fore end of the pelvis at a point of bone known as the pectinial process, runs along the inner surface of the thigh, passes the knee as a string-like tendon, and then forms one of the heads of the deep flexor muscle of the second and third toes. Its presence in birds is apparently a very definitely reptilian feature, for it exists in the majority of the lower groups of birds and is absent in most of the higher members of the class, which, we conclude, have lost it. Its reduction or loss is apparently still going on in certain groups of birds, independently in widely different groups. The presence of this muscle has been often used to explain the ease with which a sleeping bird remains on its perch. For, to use the words of the great anatomist Owen, 'it passes first over the convexity of the knee-joint and afterwards over the projection of the heel, so that from its connection with a flexor of the toes, these must necessarily be bent simultaneously with every inflection of the joints of the knee and ankle. As these inflections naturally take place when the lower extremities yield to the superincumbent weight of the body, birds are thus enabled to grasp the twigs on which they rest while sleeping, without making any muscular exertion.' Too much emphasis must not however be laid on this point as the muscle is absent in many of the most conspicuously perching of the orders of birds. Its

true function is perhaps to spread and stretch the toes when the leg is also extended, at which time the play of the muscle is free.

The toes are in reality bent by the united action of the deep plantar tendons or muscles of the toes; these are inserted in the leg proper (between the knee and the ankle); they are two in number and, as to their main shafts, their relative positions are constant. There is, however, a great deal of variation in the methods by which they divide up to connect with the toes, and these differences have been found of great assistance to classification, falling as they do into eight distinct types. Those who are interested in the point will find it described at length under the head of Muscular System in Newton's *Dictionary of Birds*, while they will notice its taxonomic value referred to in the *Fauna* under the diagnoses of the various orders, where the chief types are figured. These muscles allow the toes to be contracted both voluntarily and automatically. In the latter case, as a bird settles on a branch, the bending of its legs automatically stretches the tendons and contracts the toes. Settling down still lower to roost, till the body actually rests on the feet themselves, the tendons are still further tightened and the grip rendered still more secure. Indeed, until the bird wakes and stands upwards on its legs again, it is literally impossible for the toes to relax their grip.

In studying the various developments of a bird's foot, we must keep clearly in mind the fact that the existing foot, with its varying number of two to four toes, has been modified from the original five-toed hind limb common to the other great natural orders or their ancestors. Five toes set in a common plane were the ordinary and the satisfactory equipment of the prehistoric reptiles that peopled the then world. The number of toes might be modified if speed or an erect posture were needed, but the setting of the toes in one plane remained. It was when the bird slowly developed, and adopted an arboreal life as the necessary precursor of its powers of flight, that this arrangement needed modification. To perch is to grasp, and to grasp from both sides is to grasp more securely with a diminution of effort. To compare the foot of the arboreal apes with the foot of terrestrial man is to understand the advantage of removing one toe from the plane of the others.

It is curious that the first change in the development of a bird's foot was the loss of the fifth or outer toe. Its loss took place at so early a stage that it is found in no existing bird at all and traces of it are only to be found as a hint of the fifth metatarsal in very early embryos. The next point was to break up the existing plane of the toes so as to provide a bilateral grasping surface as we now find in almost all birds. This was done in various ways and combined with various adaptations to fit birds to live and find their food under a variety of conditions.

We will consider first what I may call the normal type of a bird's foot in which there are three toes in front and one behind. The hind toe is always the *hallux* or first toe, that is, the big toe of the human foot. The other three are the second, third and fourth counting from the inside to the outside. The number of phalanges in each toe normally increases arithmetically from two in the

hallux to five in the outer or fourth toe. The proximal or final phalange of each toe is armed with a nail or claw. This is the type of birds' foot familiar to us all in the case of the sparrow or the crow, for instance, and the type which an artist with no special ornithological leanings would automatically draw for a bird. It will be of interest to examine the modifications that such a foot is capable of suffering without in any way modifying its structural features.

Primarily such a foot is a perching foot. Its most obvious development is found in the Birds of Prey where, by an increase of strength and a developing of the claws, it becomes an instrument of grasping and striking with which the bird captures its prey.

A glance at the figure of a Sparrow-Hawk's foot will show how well adapted it is to its purpose. The claws are long, strongly curved and very sharp, and driven by the strength of which the stout foot is capable (and it has to be felt to be appreciated) they grip a bird or rat in a vice from which there is no escape unless the hawk itself is somehow induced to relax its grip. Even then the prey is probably dead or dying from the penetration of the sharp claws. There is an interesting point with which falconers alone are usually familiar. The bird of prey captures its prey in two ways. It either stoops at it and captures it with the grasp of its talons, a method which the falconer terms 'binding' to it. This may be either in the air or on the ground and is the usual method employed. Or more rarely, the falcon strikes its prey down and in this case the instrument employed is not the whole foot but the hind claw alone. I shall never forget the day when one of my trained peregrines used it. She was trained to duck and the usual method of her killing was to stoop out of the air at a party of duck on the wing, separate one of them from the others and drive it down in a long slanting flight to the ground, binding to it either in the air or just as it reached the ground. On this occasion she must have been unusually favourably placed in the air as she waited on above the jheel. For, as I flushed a little party of Gadwall, she stooped like a thunderbolt and, with a swift blow from her hind claw, knocked one of the drakes out of the party, hurling it headlong to the ground from the air. The force of such a blow is to be appreciated by the cut that it makes on the victim.

The importance of the sharp curve of the claws in the Accipitrine birds is evident from a consideration of the forms in which it is absent. A striking example will be found in the case of the Black Eagle (*Neopus perniger*). This beautiful bird compares very favourably with many of the other eagles in point of size and powers of flight. Yet it lacks their dash and courage, and, sad to relate, when it patrols low over the forest of a mountain side, sweeping backwards and forwards with a grace and beauty unsurpassed by the other eagles, it is merely birds' nesting. Sooner or later, it will spot some luckless Laughing-Thrush's nest and settling will abstract the eggs or callow young. The nobler eagles will on occasion descend to such meanness (from the human standard !) for I have seen a Tawny Eagle (*Aquila rapax vindhiana*) eating the eggs of a Red-wattled Lapwing in spite of the agitated parents' outcry ;

and I have seen another Tawny Eagle stoop on to a bush to rob the nest of a common Babbler. But the Black Eagle alone makes a practice of it, and whether they are the cause or effect, his claws render him incapable of bolder things.

Eagles, as is well known, also descend to carrion, but habitual dependence on such a diet in the case of the vultures is shown by the bluntness and weakness of their claws.

Several other points of interest are to be found in the feet of birds of prey. There is a good deal of variation in the length and thickness of the toes. The contrast between the short heavy toes of the White-eyed Buzzard (*Butastur teesa*) and the long delicate-looking toes of the Sparrow-Hawk (*Accipiter nisus*) will serve as an example. This appears to be connected both with the type of food captured and the method of eating it. The short heavy-toed birds capture, as a rule, easier and smaller prey and they tend to consume it on the ground. The birds with longer toes not only fly at higher game but very often they eat it on the branch of a tree, the feet being better able to perform at one and the same time the dual functions of grasping both the food and the branch. In such birds the addition of callous pads on the under sides of the toes tend to increase the grip. These pads are very highly developed in the Sparrow-Hawks (*Accipiter nisus*). (Fig. 1.)

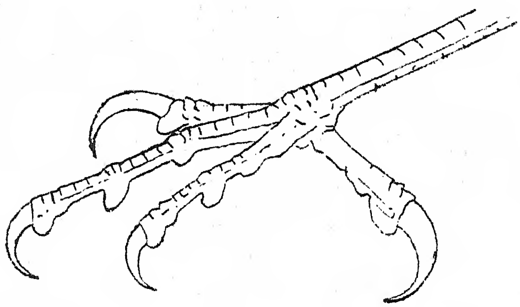


FIG. 1.—Left foot of the Sparrow-Hawk (*Accipiter nisus*). Note the pads under the toes.

One would have thought that the vice-like grip of the four claws of an accipitrine foot would have been sufficient for all purposes of holding the prey, without the need of the assistance of such pads. But the value of modifications of the sole of the foot is clearly shown in the case of the Osprey (*Pandion*), where the sole is covered with rough prickly scales. These have an evident and direct connection with the fact that the Osprey habitually feeds on fish. These it captures from near the surface of the water by dropping on them from a height with a great splash. The fish captured is often of considerable size and the value of the prickly sole in assisting the talons to hold a smooth and slippery prey is shown by the fact that a similar development is found in the large owls of the genus *Ketupa* which also feed on fish. Although unable to hint at its

meaning, I must mention that there is a good deal of variation in the arrangements of the scales which cover the tarsus and toes of the various birds of prey, and in the degree of replacements of the scales by feathers. For instance, it is difficult to see why amongst both the eagles and the buzzards one genus has the tarsus clothed in scales while another genus has the same part covered with feathers. There must be some explanation. Remembering in other families the case of the genus *Syrrhaptes* amongst the Sandgrouse, the Snowy Owl amongst the owls and the Ptarmigan[1] amongst the grouse, where these alpine forms have the whole tarsus and foot thickly clothed with feathers, one might suggest that the feathering was merely due to an extra need of warm clothing. But its presence or absence seems too capriciously distributed to bear that explanation.

A second obvious development of the normal four-toed foot is to turn it into a 'snow-shoe' (if I may misapply the word for want of a better) to enable the bird to walk on a surface that would not otherwise bear its weight. This is easily done by lengthening the toes and in India we are lucky to possess perfect examples of this in those common birds the Jaçanas (*Hydrophasianus* and *Metopidius*). In these birds the toes have been enormously lengthened and their spread still further increased by a lengthening and straightening of the claws so that the bird is able to live and walk with ease in tropical swamps where the water is too choked with weeds for swimming to be a satisfactory mode of progression. The disproportionate size of these ungainly feet is comical to a human eye, especially in the downy chicks, but they are unsurpassable for their purpose. (Fig. 2.)

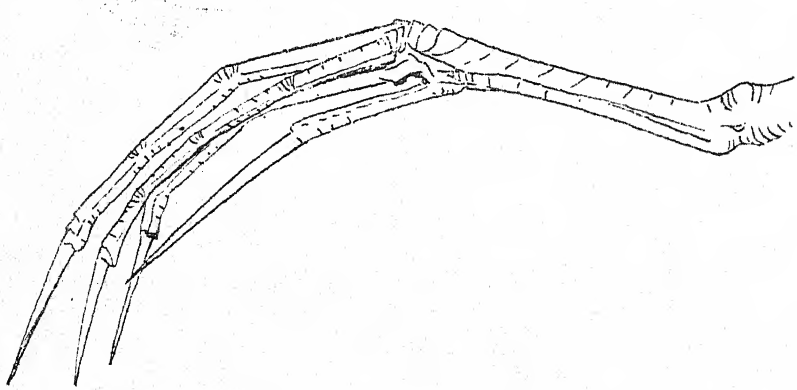


FIG. 2.—Left foot of the Pheasant-tailed Jaçana (*Hydrophasianus chirurgus*) to show the elongation of the toes and claws.

In many birds we find that the hind claw alone is lengthened without the toes or the other claws being specially modified. This

[1] In the Ptarmigan the degree of feathering on the toes varies in summer and winter: in summer the fore half of the toes is almost bare.

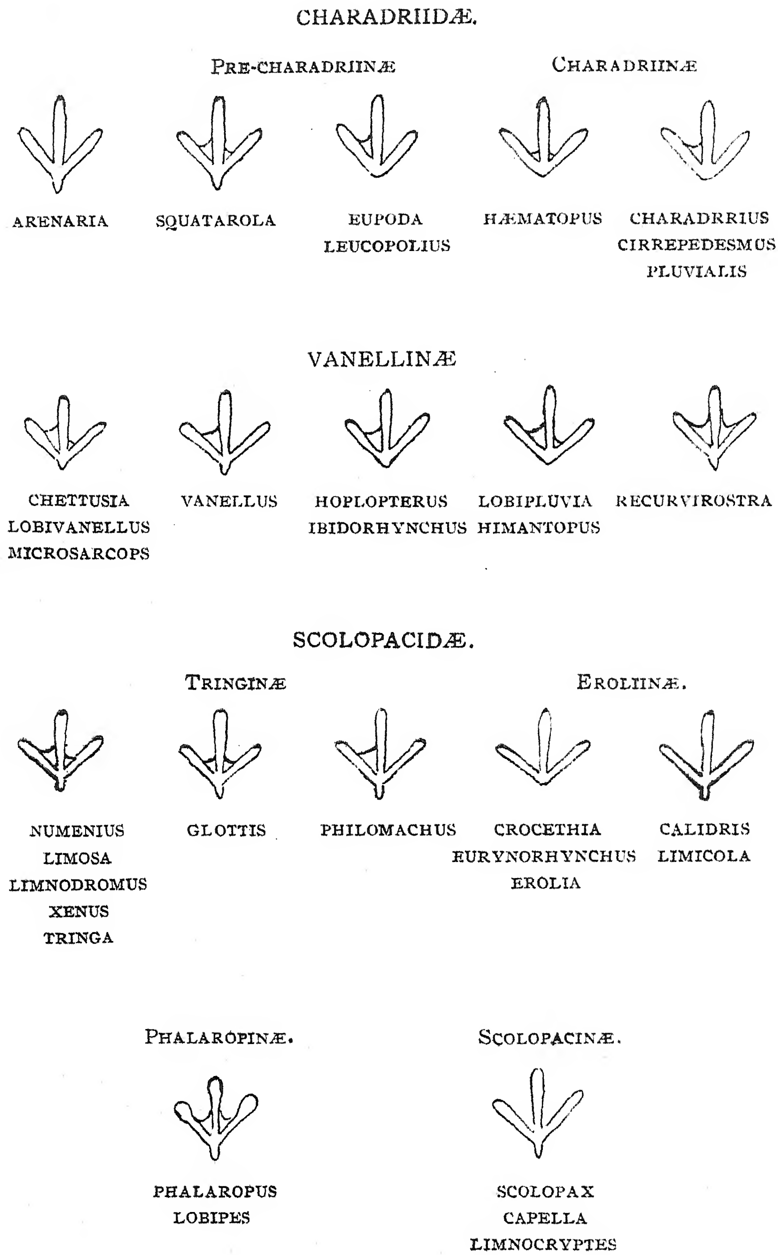


Chart of the feet of the Limicolæ, as classified in the second edition of the *Fauna*, to show that the webbing of the toes and the presence or absence of the hind-toe have no taxonomic significance.

development is connected with a terrestrial life, but its significance is not understood. For instance, in both families of the Larks and Pipits we find some species with the claw of the hallux short and others with it long. In the Larks it is usually straight, in the Pipits curved. The long claw is confined to those species which do not perch in trees, but the short claw is not confined to arboreal forms; and some with it are purely terrestrial.

A third obvious development of the normal type of foot is to fill in the space between the toes by fringes, lobes or webs. This is usually connected with the power of swimming and will be discussed separately below, but I may here remark that in some cases it is developed merely on the 'snow-shoe' principle. The leading exponents of this type of webbing are to be found amongst the Plovers and Waders and in their case it is most clearly an advantage, tending to prevent the feet sinking into soft mud. Yet even amongst them its presence, absence, and degree of development is apparently most erratic, based on no particular system as far as one can tell. The accompanying plate will illustrate more clearly than any amount of description the apparently haphazard incidence of its development amongst the Indian genera of these birds. One point emerges clearly, however, that the development of this type of web is most important between the centre and outer, that is, between the third and fourth toes. That this web has no connection with swimming is confirmed by the curious fact that in the Phalaropes, one genus of the group which habitually swims, the web is discarded in favour of the lobate type of toe, which we shall meet again in our discussion of the foot as a swimming paddle.

The partial webbing in the feet of those untypical Terns, the Marsh Terns (*Chlidonias*) and the Scissorbill (*Rhynchops*) must not be confused with the partial webbing which we have been considering. These are examples of degeneration of the swimming web in non-swimming members of the family.

A point that will not escape notice in the chart of the Wader's and Plover's feet is the also apparently erratic way in which the hallux or hind toe is often suppressed. This is the first of the departures from what I have termed the normal foot of a bird.

The suppression of a toe is never found amongst the true perching birds. It is essentially the mark of a cursorial habit, and, where the bird is accustomed to run swiftly, the suppression of the toe is usually accompanied by the shortening of the remaining toes. The reason is fairly obvious. The runner requires his weight and balance forward. So long as the hallux of a bird is large and proportionate to the other toes, it will bear a share of weight of the bird and thereby keep the centre of balance backward. Remove the hind toe and the balance automatically shifts forward. Shorten the toes and the expenditure of time and energy is lessened as between the motive impulse from the body and its communication with the ground. A long thin toe could clearly not run as quickly as a short stout one—the 'give' in it would absorb a fraction of time and a fraction of energy in every step.

The Waders, then, are essentially cursorial birds. For them the hind toe is unnecessary. The different genera merely exhibit

various stages in the degradation and disappearance of the unneeded member. The length of the other toes, however, remains as for them the support of a mud-patten is a more necessary function than speed, and to this end they are reinforced by webbing.

There is an interesting corroboration of the fact that the normal position of the hind toe is not of benefit to a cursorial bird in the *Gallinæ* or Game Bird group. In the whole of its large sub-order, Alectoropodes, the hallux is raised above the level of the other toes, evidently in order that it should not take too great a share of the weight of the body and so keep back the balance. These birds, although they perch a great deal, are essentially cursorial in habits.

Once a bird specializes above all else in running, its toes are still further truncated. The most pronounced examples of this are to be found in cases like the Thick-knee Plovers (*Burhinus*), the Coursers (*Cursorious*), the Bustards of various genera, and most conspicuously the Ostrich (*Struthio*). The typical Bustard foot has the three toes short and stout, the soles very broad and the claws short and blunt. In the ostrich only two toes now remain, the middle and the outer. The outer is reduced in size and has lost its claw, suggesting that it also is undergoing the process of elimination. We have in this a striking parallel to the case of the horse. As is well-known the foot of the existing horse has been derived from a five-toed foot. The outer toes have dwindled and almost vanished, whilst the third, corresponding to the large main toe of the ostrich, has been strengthened and modified to take all the weight. The ostrich, however, still places all its phalanges on the ground. In the horse the whole weight falls on the terminal phalanx, the nail spreading round it as a callous projection, the hoof.

That the normal avian foot of three toes in front and one behind is the ideal general utility type for both walking and perching is shown by the departures from it. Of these the most conspicuous is the Zygodactyle foot, the name invented by Vieillot a hundred years ago to describe a fairly common type of foot in which two toes are in front and two behind. (Fig. 3.)

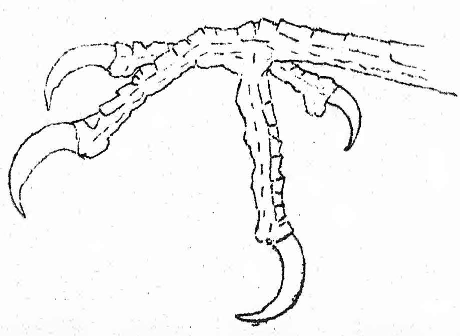


FIG. 3.—Left foot of the Scaly-bellied green Woodpecker (*Picus squamatus*) to show Zygodactyle type of foot.

The zygodactyle foot is well known to us in India. It is found in the Woodpeckers (*Pici*), the Honey Guide (*Indicator*), the Barbets (*Capitondiæ*), the Palm-Swift (*Tachornis*), the Trogons (*Trogones*), the Cuckoos and Coucals (*Coccyges*) and the Parrots (*Psittaci*). An imitation of it, by means of having the fourth toe reversible, is found in the Owls (*Striges*).

It will be noticed that with the exception of a few Coucals all these birds rarely if ever walk upon the ground. The clumsy walk of a Green Parrakeet and the jerking progression of a Woodpecker in its infrequent visits to the ground in search of ants show at once how the zygodactyle foot is ordinarily prohibitive of that means of progression, accompanied as it is generally by a shortened leg.

Two points require emphasis in connection with the zygodactyle foot. Firstly, that with one exception the two toes in front are always the second and third, and the two toes behind are the first and fourth, that is to say, that the toe which has left its normal position is the outer one. The one exception is the family of the Trogons, which have the first and second toe behind, that is, the inner or second toe has left its normal position. In possessing this type of foot, the Trogons are alone not only amongst the birds of India, but of the world. The explanation of this peculiarity is unknown, but the group is in other ways also remarkable.

Secondly, I may remark that it is as possible for a zygodactyle bird to suffer the reduction of a toe, as it is for a bird with the normal type of foot. For instance, in the following Indian genera of Woodpecker's (*Gecinulus*, *Dinopicum*[1] *Garopicoides* and *Sasia*) there are only three toes, two in front and one behind. Here as in the normal avian foot, the toe to be lost is the hallux.

There is no doubt that the zygodactyle foot is essentially a grasping arboreal foot, and it is highly efficient for its purpose. Before leaving it, I may point out the suggestive fact that in the few Coucals which have overcome the difficulty of progression on the ground, one of the most successful genera *Centropus*—sometimes called the Lark-heeled Cuckoos has a long straight claw similar to that we noticed in the Larks and Pipits. As in those birds the claw is that of the hallux.

This seems the most suitable place to mention another typically perching foot found in birds which habitually never move a step either on the ground or on a tree, their wings being their sole mode of progression. This foot consists really of three toes in front and one behind, but the toes are to a greater or less extent bound together, so that the effect is to provide virtually one toe in front with a broad perching surface and one toe behind—in use a degenerate zygodactyle foot, as it were. An examination of the feet of the Kingfishers (*Halcyones*), the Bee-eaters (*Meropes*) and the Rollers (*Coraciæ*) will show what I mean—all birds that never change their perch except by flight. The value of the broad sole

[1] It is curious that we have three Indian genera of Woodpeckers of very similar appearance and type of colouring of which *Chrysocolaptes* has the hallux well developed, *Brachypternus* very much reduced and *Dinopicum* entirely wanting.

thus provided by the fusing together of the toes is shown by the case of the pigeons (*Columbæ*). In this group the sole of the foot is considerably expanded in the more typically arboreal forms, and narrower in those that seek their food on the ground. A broad flat sole is a perching sole, and its effect is attained by the Kingfishers, Bee-eaters and Rollers.

The Swifts (*Cypseli*) are a most instructive group as regards the study of feet, showing how an extraordinary divergence of form may arise in response to the external stimuli of needs and habits, without having any deep-seated taxonomical significance. We have in India five genera of swifts and amongst them four very definite types of feet, all connected solely with their roosting and nesting habits, except in the least aberrant form *Hemiprocne*. It will be instructive to examine them in detail.

The Crested Swifts (*Hemiprocne*) are, from the point of view of an ordinary bird-lover, the most normal genus. They are long-winged, fork-tailed birds with the general appearance of a swallow; they sit on trees in forest and hawk insects in the surrounding air. They would pass as ordinary passerine birds and they have the normal avian perching foot with two toes in front and one behind.

The other genera vary as follows:—*Micropus* (typical Swifts) and *Tachornis* (Palm-Swifts) have lost a phalange from the 3rd and two from the 4th toe, that is to say, that each toe, except the hallux, has only three phalanges in place of the normal sequence of 3, 4 and 5. In *Micropus* the hallux is reversible and is normally held reversed with the effect that all four toes are directed forwards in one line. In *Tachornis* the 4th or outer toe is reversed with the effect of making a zygodactyle foot, two toes in front and two behind.

These two very divergent types are correlated very distinctly with the habits of the genera. The typical Swifts of the genus *Micropus* share with the genus *Hirundapus* the distinction of being the most highly specialized for fast flight of all living birds. Like racing aircraft their sole function is speed, and to that function all other attributes have been sacrificed. Their whole day is spent racing at headlong speed in the air. They can perch neither on tree nor on ground. A swift's only rest is to fly to a crack or hole in a cliff or cliff-like wall, from which it can again throw itself headlong into mid-air with the initial impetus from gravity that the combination of long wings and short legs deny it from any other starting place. The immensely powerful little foot, for a wounded bird can grip one's finger curiously hard with the line of toes like boat-hooks, is just the foot required for the bird to drag itself within a crevice of rock.

In *Hirundapus* the foot is the same, except that there is no reduction in the number of the phalanges, and it is curious that this is accompanied by a modification of the nesting habits, most of these swifts preferring to nest deep in the hollow trunks of trees. How they get up and down the insides of the trunks appears to be still a matter of conjecture, but presumably they must climb.

The small Edible-nest Swiftlets of the genus *Collocalia* have a similar foot with the hallux still reversible, but there is the import-

ant difference that this reversible toe is said to be normally directed backwards, that is, in the usual position of the toe in most birds. This is correlated with a type of nest which allows of more normal perching positions.

The Palm-Swift breeds, as is well known, in palm-trees, building a tiny watch-pocket of a nest affixed to the furrowed surface of the palm-leaf. Thompson's vivid description (N. & E., 2nd ed. iii, 25) of a breeding colony of these swifts, comments on the movements of the birds,—'clustering on the leaf of the palm between the ribs of the fronds. When moving up and down, they crawled with a shuffling kind of motion, as if their legs were too short for progression.'

For this swift a zygodactyle foot is evidently as for a woodpecker, a special convenience, enabling it to grasp the inequalities of the surface. The swaying of the palm-leaves in the breeze subjects it to a special strain from which the other swifts are exempt.

The study of swifts may well be commended to observers in India. I feel sure that there is a lot to be learnt from the examination and dissection of fresh specimens and that breeding colonies should be watched for first-hand information of the way the birds enter and leave their nests and how they sit inside them; while the temporary incarceration of birds in a cage for an hour or two would yield much information as to the grasping and climbing capabilities of the feet. Here I have been only able to indicate the apparent reasons for the remarkable diversity of structure of the family.

Before leaving the Swifts, I should point out that the feet of all of them are proportionately very short and small and this attribute is found in other birds, totally unrelated, such as the Swallows (*Hirundinidæ*) and the Frigate-birds (*Fregata*), which are specialized for powers of flight beyond the ordinary. Atrophy from proportionate disuse, the need to keep the balance of weight and gravity forward, and the need to tuck the feet away below the feathers and so preserve the stream-line of the body are all factors which have tended to modify the feet in this direction.

There is one final aspect of a bird's foot which now remains to be examined in detail. Its use as a propeller in water, whether for swimming or diving.

We must return again first of all to what I have termed for convenience the typical birds' foot, three toes in front and one behind. This is perfectly satisfactory in itself for swimming. A wounded bird which falls into water can show us that on occasion, and in any case we have the well-known example of the Rail family (*Rallidæ*), equally at home on land and water; many of this family have perfectly normal feet, remarkable only for the length of the toes which are specialized on the 'snow-shoe' principle to allow the bird to walk on weeds and mud and floating debris. For swimming alone the slightest modifications of this foot are easy and helpful. It is when a bird becomes a professional diver that more drastic modifications are necessary.

To deal with swimming first,—Now the successful oar or paddle

combines two functions: the maximum surface for the stroke, the minimum resistance during the return to position for the start of the next stroke. A man rowing a boat attains this combination by utilizing alternative media. He makes his stroke in the water, but draws back his oar through the air, and by this means is able to use a solid oar. Otherwise a solid oar drawn backwards and forwards in the water, without possibility of changing the incidence of resistance, would result in a stationary boat.

Without any modification at all the bird's foot is a fairly satisfactory oar; for, though it makes the backward stroke open, it naturally closes while moving forward again into position for the next stroke. Even closed, it encounters some resistance and this explains the very jerky swimming of the Water-Hen and other Rails, for, in their case there is no great margin between the resistance of the stroke and of the return movement. I had an object lesson once as to how much the resistance of the water is to even a thin thing like bird's foot, when I was watching some stilts feeding. They were wading fairly deep in the water and at each step the long legs had to be drawn upwards and backwards out of the water; to pull them out forwards through the water meant too great a strain.

The most obvious way to improve a bird's foot for swimming is to fill in the space between the three front toes. This greatly

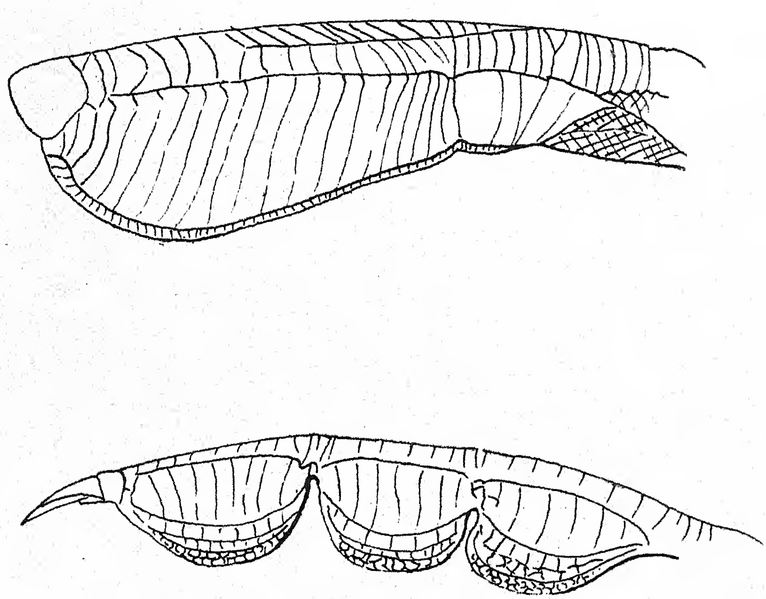


FIG. 4.—Comparison of middle toes of Grebe (upper) and Coot (lower) to show the different systems of lobes.

increases the propelling strength of the foot but does not add any appreciable resistance in the return stroke; for, the closed foot, as it

goes forward, whether webbed or free-toed, presents the same amount of surface to the water. The first step towards this ideal is found in the Water-Hen (*Gallinula chloropus*) where the toes are slightly fringed with membranes, which open and increase the propelling area when the foot makes its stroke and close again as the foot is drawn forwards through the water. The principle of this fringe is extended to its utmost in the Coot (*Fulica atra*), in the same family, where the fringes have become great lobes, a lobe for each phalange of the toe. Very similar lobes have been developed independently in the Finfoot (*Heliopais personata*) and in the little Phalaropes (*Phalaropus*). The lobe is in preference to a continuous broad fringe apparently to take the place of a series of 'gathers,' that is, to keep it stiff and straight (Fig. 4). That this system is not more common is evidently due to its inconvenience for walking. Loose projecting lobes would infallibly catch on the ground and become torn and crumpled. We shall meet the lobe again in the diving birds. So for the moment we can leave it.

The simplest and at the same time the most effective method of filling in the space between the toes is of course the web, stretching from toe to toe and held in place by their support. The commonest arrangement of this method is for the webbing to include the three front toes, leaving the hallux free, as we may see in any gull or duck. It may however include all four toes as in the cormorants and pelicans, whilst in the divers we find the hallux webbed separately on to the tarsus.

A fully webbed foot and the perfection of swimming powers may be possessed by a bird without any profound modification of its general structure. I have mentioned a gull as a possessor of a fully-webbed foot and we are all accustomed to see how beautifully a gull can swim and ride on the water. This, however, is only one aspect of the gull's life and by no means a dominant one and it has therefore not affected the other parts of its body. The hind limb and the pelvic girdle of the gulls remain the same as those cursorial birds, the plovers, their close relatives.

Directly, however, swimming becomes the dominant feature of a bird's life, the hind-limb and pelvic girdle are affected. The tendency is for the pelvis to elongate and grow narrow and for the hind-limb to move backwards, the proper position for a propeller.

The sequence of these changes is well shown in the ducks and the grebes and divers and their highest degree was curiously enough reached in the extinct diver *Hesperornis*. Amongst the ducks the modification of the pelvis present in all is greater in the diving forms.

Amongst our Indian birds the highest degree of such specialization is reached amongst the Grebes (*Podicepidæ*). In them, in addition to the other changes, the thigh bone is greatly shortened and the knee joint is almost permanently bent, with the result that the only part of the leg which is visible externally to the skin is the scale-covered tarsus and foot. These project from the body much in the same position as in a human being, the tail being degenerate and hard to find, with the result that, if a grebe attempts to stand on land, its position is erect and not as in most birds more

or less horizontal. As a matter of fact a grebe hardly ever visits the land; to walk or even to stand must be a great effort for it as one may readily appreciate from a consideration of the structure of the knee (Fig. 5). It will be noticed that a bony spur, roughly pyramidical in shape, rises above the upper end of the tibia at the knee joint. This is to support the extraordinarily abnormal development of the leg muscles for swimming. It is formed by a prolongation of the cnemial crests (the bony ridges for the attachment of the muscles of the lower leg found in all birds) and their fusion with a large patella (knee-cap bone). This spur would be in the way of the tibia, were not a groove hollowed in it to allow of play in the bone; but even so it restricts its free play and explains why movement on the land is difficult to a grebe. In the Divers (*Colymbus*) specialization on these lines has gone still further. The spur is proportionately longer and composed almost entirely of exaggerated cnemial crests, the patella being a mere functionless vestige, so that even less play is possible in the joint, whilst the toes have lost the power of bending forward on the shank of the tarsus. The result is that the Diver cannot walk at all on land and, though it nests on small islands, it has to move between the eggs and the water on its belly, propelling itself with its legs behind.

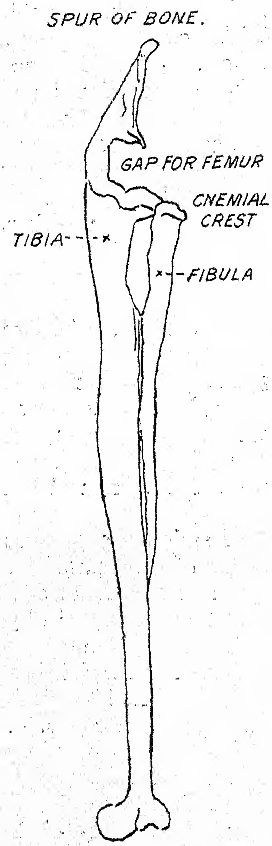


FIG. 5.—Shank of Great Crested Grebe (*Podiceps cristatus*) to show the spur for the attachment of the swimming muscles.

(After Pycraft).

The final touch in the development of a bird's foot as a swimming paddle is to deflect its striking surface sideways at an angle to the body. This is well seen not only in the Grebes but in the *Steganopodes*, the group which contains the Pelicans, Frigate-birds, Cormorants, Gannets and Tropic-birds, all represented on our Indian list.

In the *Steganopodes* all four toes are united with a web to make the paddle surface, the hallux being turned inwards to bring it into line. In the figure of a shag's foot it will be noticed how the proportions of the toes have been modified for the symmetry of the paddle (Fig. 6).

The same result has been attained in the Grebes by a flattening and expansion of the toes. A first step in such a development can be seen amongst the ducks, where the diving forms have the hind toe flattened into a broad lobe as compared with the surface-feeding species. As the Grebes represent in India the extreme limit of the

specialization of the foot for swimming, it will be of interest to examine their foot in detail: but I may first point out that this type of lobed foot differs from that of the Coot in one important particular.

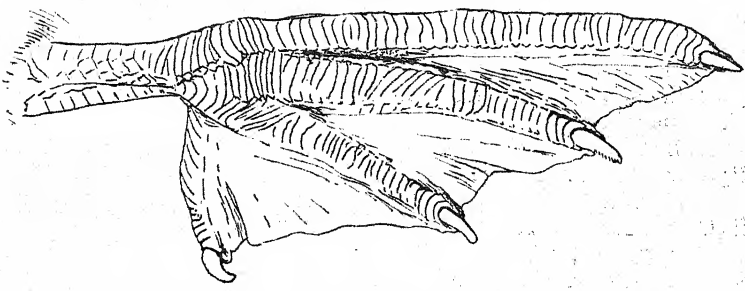


FIG. 6.—Left foot of a Cormorant (*Phalacrocorax*).

Each toe consists of one large lobe, not a series of lobes to correspond with the phalanges. This difference is possible, because the foot is no longer required for walking. The lobe itself can be stiff and stout enough to do away with the need of any support, other than that afforded by the sideways cast of the toes.

Examining the foot of a Little Grebe (*Podiceps capensis*) we are immediately struck by two marked characteristics—flatness and one-sidedness. Each foot is all on one side, grouped on the inner side of the axial line, with its surface plane facing inwards and backwards. The three lobed toes when closed combine into a single surface. The second and fourth toes lie flat under the (third) central toe, its broader free flange setting the slope of the plane (Fig. 4).

The result is that in swimming the foot presents practically no resistance to the water during the forward stroke, slipping through the water with this flattened plane sideways. Then for the backward stroke the toes open and the lobes spread out, so that the greatest possible surface strikes the water.

The broadly lobed hallux, so like that of the diving ducks, has no connection with steering, as one might at first surmise. It is merely lobed to add its contribution to the broad stroke surface; and as the foot comes forward again preparatory to a fresh stroke, the hallux slides within the lobes of the closed toes so that its share of resistance to the water is almost entirely cut away.

A second reason that the toes are flattened sideways is that the Grebe, like the other expert swimmers swims, with sideways strokes, kicking from side to side behind its body, not backwards and forwards under it. The action of the two legs closing behind the body at the end of the stroke is to drive out the water between and so propel the body forward.

Two minor accessories of a bird's foot must be briefly noticed before I bring this chapter to a close.

The spur of the game birds *(Gallinæ)* is well known, situated on the back of the tarsus. It varies in shape and size from a small rudimentary lump to the long curved sharp stiletto of the Jungle

Fowls. When well developed it is used for fighting and on occasion proves a mortal weapon. Normally one spur occurs on each leg and it is usually confined in most species to the male. In the Spur-fowls *(Galloperdix)* its development is curiously unstable. In the males two or three spurs may be found on one leg and instances of four spurs have been recorded, while the female bird may on occasion have two spurs on one leg. The number of spurs on each leg may even differ.

The pectination of the claw is less well known. The most generally known case of such pectination is in the middle toe of the Nightjars *(Caprimulgus)* and this is usually explained as forming a comb to clean insect scales off the long bristles that surround a Nightjar's month. A knowledge, however, that pectination is found in other species, where such an explanation is not possible (as for instance the case of the Shag, fig. 6) shows that some other reason must be looked for. After all it may be nothing more than a form of 'roughing' to increase the perching powers of birds whose hallux is of little value to this end.

(*To be continued.*)

REVISION OF

THE FLORA OF THE BOMBAY PRESIDENCY.

BY

E. Blatter, S.J., Ph.D., F.L.S.

PART XII

(*Continued from page 26 of this volume.*)

ANNONACEÆ (Cke. i, 8).

Uvaria, Linn. (Cke, i, 8).

Cooke (i, 9) describes 2 species: *Uvaria Narum*, Blume Fl. Java Anon. (1828), 5, and *U. Hookeri*, King in Ann. Roy. Bot. Gard. Calc. iv, pt. 1 (1893), 28.

King (l.c.) had split up *U. Narum*, Wall. of the Fl. Br. Ind. i, 50 into those 2 species, and in this he was followed by Cooke and Talbot For. Fl. Bombay (1909), 15-16.

Gamble. [Fl. Madras (1915), 13] again unites *U. Hookeri*, King with *U. Narum*, Wall.

So far it was only a question whether the biseriate arrangement of the seeds, the carpels tapering at one end and mounted on longer and thicker stalks, and larger leaves and flowers are sufficient reason to retain King's new species *U. Hookeri*. Cooke's opinion on this point is not of decisive value as he had not seen any specimen of *U. Hookeri*. Talbot figures both species (figs. 9 and 10) and if these figures are somewhat correct, there can scarcely be a doubt that the two species are distinct. I must add that, not having seen a specimen of *U. Hookeri*, I am merely judging from King's and Talbot's illustrations.

The distribution of the two species is this:

U. Narum, Blume: *Bombay Pres.*: Konkan, N. Kanara; *Madras Pres.*: Forests of the W. Ghats from S. Kanara to Travancore, hills of Salem up to 4,000 ft.

U. Hookeri, King: Konkan, some evergreen rain-forests of the N. Kanara Ghats, Belgaum Ghats.

Artabotrys, R. Br. (1820); Cke. i, 9.

Cooke has 2 species: *A. odoratissimus*, R. Br. and *A. zeylanicus*, Hook. f. & Th.

The first should be called:

Artabotrys uncinatus, (Lam.) Merrill in Philipp. Journ. Sc. Bot. vii (1912), 234.—*Anona uncinata*, Lam. Encycl. ii (1786), 127.—*Artabotrys odoratissimus*, R. Br. in Bot. Reg. (1820), t. 423, *auctores multi alii*.

Anona uncinata was described by Lamark in 1786 from specimens gathered by Sonnerat in the E. Indies and Madagascar (*vide* Dunal Anon., pls. 12 and 12a).—*Artabotrys odoratissimus*, R. Br. is the type species of the genus established in 1820. According to Craib, it was described originally from a plant introduced into England from Calcutta.

Native probably of S. India and Ceylon.

Desmos, Loureiro Fl. Cochinch. (1790), 352.

(= *Unona*, Linn. *partim*; Cke. i, 10).

The genus *Desmos* was founded by Loureiro in 1790 and based upon *Desmos cochinchinensis* (*Unona Desmos*, Dunal, 1817, *Unona cochinchinensis*, DC., 1824).

Vide W. E. Safford, Bull. Torrey Bot. Club 39 (1912), 501-8.

Description of genus: Sepals 3; petals 6 in 2 series, valvate, nearly equal, flat; stamens numerous, tetragonal-oblong or cuneate, the connective expanded above the dorsal oblong or linear-oblong pollen-sacs into a truncate hood-like process; receptacle, or torus, slightly raised, usually truncate or somewhat concave at the apex; carpels indefinite; ovules several, usually forming a single column, but sometimes sub-biseriate; style ovoid or oblong, recurved; ripe carpels indefinite, either elongate and chain-like from constrictions between the seeds, or baccate and spheroid.

Species about 33.

The 3 species of *Unona* mentioned by Cooke must be changed into:

1. **Desmos pannosus**, Safford in Bull. Torrey Bot. Club 39 (1912), 506.—*Unona pannosa*, Dalz. in Hook. Kew. Journ. Bot. iii (1851), 207; Hook. f. F.B.I., i, 58; Cke. i, 11; etc.—*U. farinosa*, Dalz. and Gibs. 3.

Description: Cke. i, 11.

Locality: Konkan; N. Kanara: Evergreen rain-forest of the Gersoppa Ghat near Mulamane; W. Ghat forests up to 3,500 ft.

Distribution: W. Ghats in Malabar, Anamalais, Travancore and Tinnevelly, at 2,000 to 4,500 ft.

2. **Desmos chinensis**, Lour. Fl. Cochinch. (1790), 352.—*Unona discolor*, Vahl. Symb. ii (1791), 63, t. 36; Hook.f. F.B.I. i, 59; Cke. i, 11; etc.—*U. Dunalii*, Hook.f. & Th. Fl. Ind. 131 (only as far as the Konkan plant is concerned).

Description: Cke. i, 11.

Locality: Konkan: Sivapur in the Wari country (Dalz. and Gibson). Cooke mentions 'Kanara in evergreen forests' on the authority of Talbot, but Talbot states in his For. Fl. that he has not seen it. As there is no specimen available gathered by Dalz. and Gibs., the occurrence of this species in the Presidency is very doubtful.

Distribution: The distribution of the species given by Hook. f. and Th. in F.B.I. i, 59 is equally doubtful and requires re examination. It seems to be certain that the plant is indigenous in S. China, Indo-China, Siam and the Malay Archipelago.

3. **Desmos Lawii**, Safford in Bull. Torrey Bot. Club 39 (1912), 506.—*Unona Lawii*, Hook. f. & Th. Fl. Ind. (1855), 132; in Hook. f. F.B.I. i, 59; Bedd. Ic. Pl. Ind. Or. t. 73; Cke. i, 11; etc.

Description: Cke. l.c.

Locality: Konkan: Wari.—*N. Kanara:* Near Goond in the Supa sub-division.

Distribution: W. Ghats in Mysore, Wynaad, Travancore and Tinnevelly, 200-3,000 ft. (Gamble).

POLYALTHIA, Blume (Cke. i, 12).

Complete and correct the synonymy given by Cke.

Polyalthia cerasoides, Benth. & Hook. f. Gen. Pl. i, 25.—*Guatteria cerasoides* Dunal Monogr. Anon. (1817), 127.—*Uvaria cerasoides*, Roxb. Cor. Pl. i (1795), 30, t. 33.—*Unona cerasoides*, Baill. ex Pierre Fl. For. Cochinch. (1880), t. 26.

Distribution: India, Burma, Cambodia, Siam, Cochinchina, Laos.

ANNONA, Linn. (not *Anona*). Cke. i, 14.

Key to the 3 species cultivated in the Bombay Presidency.

1. Fruit tubercled ... ... 1. *A. squamosa*.
2. Fruit smooth, slightly areolate ... ... 2. *A. reticulata*.
3. Fruit bearing numerous fleshy spines ... ... 3. *A. muricata*.

ad 3. **Annona muricata**, Linn. Sp. Pl. 536.

Popular Names: Soursop, Guanabana.

Description: A small evergreen tree. Leaves leathery, ill-smelling, obovate-oblong or oblanceolate, to ovate or elliptic, acute or abruptly acuminate, glossy above and rusty beneath, but at length glabrous, with the minute pockets in the axils of the lateral veins scarcely perceptible without a lens. Flowers large, the exterior petals thick and fleshy, ovate-acute, valvate or edge-to-edge, the interior petals somewhat smaller and thinner, concave,

rounded, imbricate or overlapping. Fruit very large, fleshy, ovod or heart-shaped, dark green, the glabrous ill-smelling skin bearing numerous recurved fleshy spines; pulp white and juicy, pleasantly subacid, with a slight mango-like flavour.

Distribution : A native of tropical America, now common in the tropics of the Old World.

MILIUSA, Alph. DC. (Cke. i, 15).

The confusion attached to this genus has not been removed as yet.

Dunn wrote in Kew Bull (1916), 58 : 'The common S. India tree described under the name of *M. indica* by Hook. f. & Thomson (Fl. Ind. 148 ; Fl. Brit. Ind. i, 86) and by Wight and Arnott (Prodr. 10) and figured by Beddome (Pl. Ind. Or. t. 85) has been shown to me by Mr. J. R. Drummond to differ in so many respects from the figure and description of Leschenault's tree *M. indica* (Lesch. in A. DC. Mem. Soc. Genèv. v, 36) that it is necessary to distinguish it under a separate name. As no such name has yet been published, I propose with Mr. Drummond's concurrence, to call it *Miliusa eriocarpa*, Dunn, in reference to its velvety carpels.'

A year previous to this note Gamble (Fl. Madras pt. i, 21) had published the new name and made it clear that Dunn's *M. eriocarpa* is the var. *tomentosa* of Hook. f. and Thoms's *M. indica* in the Fl. Brit. Ind. (not of Lesch.).

What about *Miliusa indica*, Leschen in Cke.'s Flora of Bombay(vol. i, p.15)? Judging from his description and synonymy his *Miliusa indica* must be called *M. eriocarpa*, Dunn.

But does the plant occur in the Bombay Presidency? Previous to Cooke it was mentioned in Talb. Trees, Bomb., p. 5 and by Woodrow in Journ. Bomb. Nat. Hist. Soc. 11 (1897), 120. Cooke (in 1903) says that he had seen a specimen collected by Talbot at Poteli in N. Kanara. The strange thing is that Talbot in his For. Fl. Bombay Pres. (1909) vol. i, omits the genus *Miliusa* entirely. Was it an oversight or did he come to the conclusion that what he called *M. indica* before, was not a *Miliusa* at all?

As I have not seen any Bombay specimens of *Miliusa*, I must leave the occurrence of that genus in the Presidency as doubtful till further material is available. J. R. Drummond's paper on '*Miliusa* and *Saccopetalum*' in the Journ. Ind. Bot. (1920), 162, will be useful in clearing up the many doubtful points connected with the species of *Miliusa*.

SACCOPETALUM, Bennett.

Baillon (Hist. des Plantes, 244) had reduced this genus to *Miliusa*. Drummond [Journ. Ind. Bot. (1920), 165-168] has tried again to make that reduction with a good deal of sound argumentation. Till, however, *Miliusa* and *Phaeanthus* are better known, it seems to be preferable to retain the genus *Saccopetalum* in the meantime.

Drummond makes a suggestion which deserves being seriously considered by systematic botanists : 'The arrangement of the highly natural but difficult family of the *Anonaceæ* might possibly be simplified, if instead of attempting to distinguish between "sepals" and "petals", the floral envelope were treated, for taxonomic purposes, as a single perianth, consisting of subsidiary, sometimes sharply differentiated whorls.'

SAGERAEA, Dalz.

Hook. f. and Th. (in Hook. f. F. B. I. vol. i, p. 92) had united *Sageraea* with *Bocagea*, St. Hil. King separated them again (Ann. Roy. Bot. Gard. Calc. iv, (1893)). He did not think it possible to combine the extreme imbrication of the sepals and petals in *Sageraea* with the valvate calyx and corolla of *Bocagea*. Talbot, Brandis and Gamble have followed him.

General characters of *Sageraea* : Trees ; leaves smooth, shining. Branches glabrous. Flowers small, terminal, axillary, or fascicled on woody tubercles, 1–2-sexual. Sepals 3, orbicular or ovate, imbricate. Petals 6, imbricate in 2 series ; nearly equal, usually orbicular and concave. Stamens 6–21, imbricate in 2 or more series, broadly oblong, thick, fleshy ; anther-cells oblong ; connectives produced, not hiding the anthers. Ovaries 3-6 ; style short, stigma obtuse or capitate ; ovules 1–8 on the ventral suture. Ripe carpels stalked, globose.

Only 1 species in the Bombay Presidency.

Sageraea laurifolia (Grah.) *nov. comb.*—*Guatteria laurifolia*, Grah. Cat. Bomb. Pl. (1839), 4.—*Sageraea laurina*, Dalz. in Kew Journ. Bot. III (1851), 207; Dalz. and Gibs. Bomb. Fl. 2; Hook. f. and Th. Fl. Ind. 93; King in Ann. Roy. Bot. Gard. Calc. iv, pt. i, (1893), 7 *et* pt. 2, t. 35 B (*partim*); Talbot For. Fl. Bomb. i, (1909), 33; (*partim*); Brandis Ind. Trees (1911), 13; Gamble Ind. Timb. (1992), 15 (*partim*);—*Bocagea Dalzellii*, Hook. f. & Th. in Hook. f. F.B.I. I (1875) 92 (*partim*); Cooke Fl. Bomb. vol. i, p. 17 (*partim*).

The oldest name of this species is *Guatteria laurifolia*, Grah. As to the synonymy it must be remembered that Gamble [Fl. Madras (1915), 12] separated as a distinct species *Sageraea Dalzellii*, Bedd. Ic. Pl. Ind. Or. t. 42 from *Bocagea Dalzellii*, Hook. f. and Th.

NYMPHAEACEÆ

Before indicating the changes that have to be made in this family, it may be useful to reproduce a few remarks made by Sprague in the Kew Bull. (1926), 99: 'The genus *Nymphaea* L. (Sp. Pl. 510; Gen. Pl. ed. 5, 227) included the white water-lilies, the yellow water-lilies and the nelumbo, which are now regarded as belonging to three distinct genera. Adanson separated *Nelumbo* generically in 1763, and Salisbury in 1805 segregated the white water-lilies as *Castalia*, retaining the name *Nymphaea* for the yellow water-lilies. But as Conard (Rhodora, 1916, xviii, 161–164) has pointed out, Linné's generic description of *Nymphaea* was evidently drawn up primarily from the white water-lilies, as witness the phrase '*petala germinis lateri insidentia*.' The standard-species of *Nymphaea* should accordingly be selected from the white water lilies, of which there were two in Sp. Pl. ed. i, namely *N. alba* and *N. Lotus*. The former is obviously indicated, as it was much better known to Linné.'

We shall therefore retain the genera *Nymphaea* (not *Castalia* Salisb.) and *Nelumbo*, Adans. (not *Nelumbium*, Juss.).

NYMPHAEA, Linn.[1]

Conard (l. c.) does not in his Monogragh identify any Indian plants with the *Nymphaea lotus* of the Linnean herbarium, but he follows Wight and Arnott (Prodr. i, 17) in separating from it as distinct species, on account of the colour of their flowers, *N. rubra*, Roxb. and *N. pubescens*, Willd.

There are 3 species in the Bombay Presidency:

1. **Nymphaea rubra**, Roxb. ex Salisb. Parad. Lond. 1, *sub* t. 14, Fl. Ind. ii, 576; Grah. Cat. Bomb. Pl. 5; W. & A. Prodr. 17; Wight Ill. i, t. 10.—*N. lotus*, Hook. f. & Th. Fl. Ind. 241, in Hook. f. F.B.I. i, 114 (*non* Linn.); Dalz. & Gibs. Fl. Bomb. 6; Trim. Fl. Ceyl. i. 49; Cke. i, 25.—*N. lotus* var. *rubra*., Haines Bot. Bih. & Or. (1921), 21.
Description: Cke. l.c.

2. **Nymphaea pubescens**, Willd. Sp. Pl. ii, 1154; W. & A. Prodr. 17; Grah. Cat. Bomb. Pl. 6; Gamble Fl. Madras 34.—*N. lotus* var. *pubescens*, Hook. f. & Th. Fl. Ind. (1885), 241; Hook. f. F.B.I. i, 114; Cke. i. 25.—*Castalia pubescens* (Willd.) Blume Bijdr. 48.

3. **Nymphaea stellata**, Willd. Sp. Pl. ii (1797), 1153; etc. as in Cke. i, 25.

NELUMBO, Adans. Fam. i (1763), 73.

(*Nelumbium*. Juss. Gen. (1789), 68; Cke i, 26).

1. **Nelumbo nucifera**, Gaertn. Fruct. i, (1788) 73, t. 19, f. 2.—*Nelumbium speciosum*, Willd. Sp. Pl. ii, 1258; Cke. i, 26.—For synonyms see Hook f. & Th. in Hook. f. F. B. I. i, 116.

PAPAVERACEÆ (Cke. i, 26).

PAPAVER, Linn. (not in Cke.).

Annual or perennial herbs with milky juice. Leaves variously lobed or cut. Flowers on long peduncles. Ovary 1-celled; stigmas adnate, radiating. Capsule short, opening by pores round the upper rim. Seeds small, pitted.

[1] There seems to be no relation between the size of the chloroplasts and systematic position. See M. Möbius, Ueber die Grösse der Choroplasten. Berl. Deutsch. Bot. Ges. 38 (1920), 224–32.

Species about 100.—1 cultivated in the Presidency.

1. **Papaver somniferum**, Linn. Sp. Pl. ed. 1 (1753), 508 ; Roxb. Fl. Ind. ii, (1820–24), 571 ; W. & A. Prodr. Fl. Ind. (1834), 17 ; Hook. f. & Th. Fl. Ind. (1855), 256, *et* in Hook. f. F. B. I. i, 117 ; Patwardhan Field, Garden and Orchard Crops of the Bombay Pres. in Bull. 30 (1928), 2 of the Dept. Agric. Bomb.

Popular Names : Opium Poppy ; Afim (Hind.) ; Afu (Mar.) ; Afimu (Kan.)

Distribution : A stout herb, 60–120 cm. high, glaucous, with oblong, amplexicaul, lobed, toothed and serrate leaves and large white, purple or scarlet flowers. Sepals glabrous. Capsule large, 2·5 cm. diam. Seeds numerous, white or black.

For the numerous varieties and forms see Borckhausen in Rhein. Magaz. i (1793), 444 and Alefeld Landw. Flora (1866), 228, 229.

Localily : Cultivated as a cold weather crop only in the Baroda State (Patwardhan).

Description : It is doubtful whether the plant has ever been found wild. Cultivated in temperate and warm regions.

CRUCIFERÆ[1]

CARDAMINE, Linn.

The only species found in the Presidency was described by Hook. f. & Anderson as *C. subumbellata*, Hook. in the F.B.I. i (1872), 138. (In Cke. i, 30 *C. subumbellata*, Hook. f. & T. Anders).

In the meantime S. T. Dunn [Kew Bull. (1916), 61] has pointed out that **Cardamine trichocarpa**, Hochst. ex Rich. Tent. Fl. Abyss. I (1847), 18 is identical with the Indian *C. subumbellata*. *C. trichocarpa* must therefore be substituted.

Has this species 4 or 6 stamens ? In his description Cooke mentions 6. It is for this remark that for years together I was unable to name one of the commonest plants at Panchgani. It agreed in everything with *C. trichocarpa* except that it had only 4 stamens. Finally I asked Mr. K. Biswas of the Sibpur Botanic Garden to compare the plant with herbarium material. This is what he writes : 'I have examined the specimens of *Cardamine* growing, as we found, almost everywhere in and about Panchgani. Comparison with the herbarium material shows that the herbarium specimens taken as *Cardamine subumbellata* agree in all respects with the Panchgani specimens. Their discrepancy from the description of *C. subumbellata* lies in the number of stamens which are only 4 in both the herbarium and Panchgani material. Cooke in his *Bombay Flora* [i (1903), 30] mentions 6 stamens : but my examination of a large number of flowers and flower buds reveals that there are only 4 stamens, evidently the 4 inner larger ones in pairs. The 2 stamens opposite the lateral sepals of the outer series are wanting in every case. There are 2 glands at the base of the outer sepals. These might be taken for the remnants of the 2 abortive stamens. But I am not sure about the exact morphological nature of these protuberances. Neither Hook. f. & T. Anders. in Hook. f. Fl. Br. Ind. [i, (1875), 138] where they describe *C. subumbellata* nor Dalzell in Hook. Kew Journ. Bot. [iv (1852), 294], where he describes *C. hirsuta*, Linn. var. *subumbellata*, say anything about the number of stamens or glands. In Engler's Pflanzenfamilien not much importance is attached to the number of stamens.' Considering everything it is more likely that Cooke made a mistake in giving the species 6 stamens. He saw and collected specimens at Mahableshwar, but that plant is exactly the same as the one found at Panchgani.

FARSETIA, Desv. (Cke. i, 30).

In his description of the genus Cooke says that the pods are sessile ; in this he followed the Fl. Brit. Ind. I have always found them stalked and Boissier describes them as such.

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[1] For the systematic study of this order, see : Hayek, A. von : Entwurf eines Cruciferen-Systems auf phylogenetischer Grundlage. Beiheft Bot. Centralbl. xxvii, Abt. 1 (1911), 254. Schulz, O. E. *Cruciferæ-Brassiceæ*. In Engler's Pflanzenr. iv, 105 (1919 and 1923).

ERUCA, Tourn. Inst. (1700), 226, t. 111[1]; (Cke. i, 31).

The authority for *Eruca sativa*[2] is Garsault Traité pl. anim. ii (1767), 166, t. 259, not Miller Gard. Dict. ed. 8 (1768) n. 1 of Cooke's Flora i, 31, and not Lam. Fl. Franc. ii (1778), 496 of the F.B.I. i, 158.

DOUEPIA, Camb. in Jacquemont Voy. Ind. iv (1844)
Bot. p. 18, Atlas ii, t. 18.

O. E. Schulz [in Engl. Pflanzenr. iv, 105 (1923), 72] has separated *Douepia* from *Moricandia*, DC. The differences between the two genera are these:

Moricandia, DC.: The inner sepals saccate. Petals broad. Median nectariferous glands absent. Pods compressed. Ovules 40–200.

Douepia, Camb.: The inner sepals not saccate. Petals narrow. Median glands rather large. Pods slightly terete. Ovules about 28.

DOUEPIA, Camb.[3]

Perennial herb, branched. Leaves undivided, fleshy, lower ones shortly stalked, upper ones sessile. Racemes very lax. Flowers large. Sepals erect-patent, the outer ones linear, cucullate at the apex, the inner ones narrowly oblong, acute at apex, not saccate at base. Petals rosy, narrow, oblong-cuneate, rounded at the apex. Median nectariferous glands rather large, oblong-ovoid, the lateral ones semi-circular. Stamens 6, free; anthers large, linear, acute. Ovary very narrowly cylindrical, sessile; ovules few to 28; style short; stigma large, distinctly 2-lobed. Pods linear, slightly terete, bilocular, septate, dehiscing, slowly attenuate into an acute beak which is often tortuose. Seeds pendulous, uniseriate, ellipsoid, brown, with a membranous wing.

So far only 1 species is known, indigenous in the Indian Desert region.

1. **Douepia tortuosa,** Camb. in Jacquem. Voy. Ind. iv, Bot. (1844), 18, t. 18; Schulz in Engl. Pflanzenr. iv, 105 (1923), 72, fig. 21.—*Moricandia tortuosa,* Hook. f. & Th. in Journ. Linn. Soc. Bot. v (1861), 172; Hook. f. & T. Anders. in Hook. f. F.B.I. i, 158; Cke. i, 32; Woodr. in Journ. Bomb. Nat. Hist. Soc. 11 (1897), 122.

Description: Cke. i, 32.

Locality: Sind (ex Woodrow).

Distribution: Salt plains of the Punjab, Salt Range, along the Salt Range between Musakel and Gujarat, 1,600–2,800 ft. N. Waziristan.

BRASSICA, Linn. Sp. Pl. ed. 1, ii (1753), 666 (*partim*).

Species 33.—In the Bombay Presidency only cultivated species:

A. Ovary multi-ovulate (9–45). Pods 1·5–10 cm. long. Beak distinctly conical, sometimes as thick as the pod, often 1- or 2-seeded
  I. Stem-leaves amplexicaul.
    1. Flowers not surpassing the buds at flowering
      a. Calyx closed. Petals pale yellow, 1·8–2 cm. long. Pods with undulate margins. Leaves more or less fleshy — 1. *B. oleracea.*
      b. Calyx half-open. Petals intensely yellow. 0·9–1·8 cm. long. Pods with straight margins. Leaves membranous ... ... 2. *B. napus.*
    2. Flowers surpassing the buds at flowering. 3. *B. campestris.*
  II. Stem-leaves sessile or petiolate ... ... 4. *B. juncea.*
B. Ovary few-ovulate (5–11). Pods 0·8–3 cm. long. Beak vary thin, always seedless ... 5. *B. nigra.*

[1] O. E. Schulz in Engler's Pflanzenreich has *Eruca*, Adans. Fam. II (1763), 418. *Cur*?

[2] On pollination, see: A. G. Howard, L. C. Howard and A. R. Khan—Studies in the pollination of Indian Crops. Mem. Dept. Agr. India (Bot. ser.) 10 (1919), 195–220.

[3] Cambessēdes gave this name in order to commemorate the services of Herman von Douep rendered to science by his translation into Latin of Rheede's Hortus Malabaricus.

1. **Brassica oleracea,** Linn. Sp. Pl. ed. 1, ii (1755), 667 (*excl.* var. x); Freeman Ic. Brit. Plants i (1797), t. 4, 5, n. v; Smith & Sowerby Eng. Bot. ix (1799), t. 679; Hegi, Ross, Thellung in Illustr. Fl. Mitt. Eur. iv, fasc. 38 (1918), 242; Schulz in Engl. Pflanzenr. iv, 105 (1919), 27.

Description: Suffruticose, 0·5–1·5 m. high. Stem branching in the upper part, obtusely angular, quite glabrous; branchlets suberect. Basal and lower cauline leaves large, approximate, stalked, lyrate-pinnatipartite, nerves stout, white, prominent especially below, terminal lobe very large, suborbicular or ovate, often obscurely 5-lobed, rounded at the apex, margin crenulate and undulate, at the base obliquely cordate, lateral lobes on each side 3–5, much smaller, obovate, recurved, the upper ones crenulate, the lower ones very small, entire; the middle cauline leaves amplexicaul, oblong-obovate, obtuse, repand-denticulate; the upper leaves oblong-linear, entire or almost so; all fleshy, glabrous, green-glaucous. Racemes 20–40–flowered. Pedicels 6–8 mm. long. Flowers large. Sepals 1–1·1 cm. long, the outer ones narrowly oblong, the inner oblong-ovate, obtuse, erect. Petals pale yellow, 1·8–2 cm. long, blade obovate, rounded at apex, sometimes undulate, gradually narrowed into the claw. Inner stamens 13 mm. long, outer 11·5 mm.; anthers 3·8 mm. long, narrowly oblong, slightly acute. Ovary 34-37–ovuled; style 3 mm. long. Fruiting pedicel 1·5–2 cm. long, erecto-patent; pods irregularly spreading or ascending, linear, 6-9 5 cm. long, 4–5 mm. diam., compressed-tetragonous, torulose, often serpentine-flexuose, running out into a beak 4-6 mm. rarely 15 mm. long, which is first uniformly tumid and then attenuate, mostly 1–seeded, sessile at the base or with a stalk 2–3 mm. long; valves firm, each with a stout nerve and thinner, lateral, anastomosing veins. Seeds globose, 1·5-2 mm. diam., pendulous, obscurely brown, minutely alveolate.

The following are the varieties and forms cultivated in the Bombay Presidency:

(*a*) **B. oleracea,** Linn. var. **acephala,** DC. *excl.* var. x.—*B. acephala,* DC. *ap.* Léveillé Monde, Pl. xii (1910), 24, n. v.

Popular Names: Scotch Kail, borecole, Blattkohl (in German).

Description: Stem elongate, firm at the base but not woody, simple or almost so, biennial, rarely lasting for 3–4 years and branching. Leaves expanded.

(*b*) **B. oleracea,** Linn. var. **bullata,** DC. subvar. **sabauda,** Linn.

Popular Name: Savoy Cabbage.

Description: Leaves distinctly blistered, more or less undulate, mostly simple.

(*c*) **B. oleracea,** Linn. var. **bullata,** DC. subvar. **gemmifera,** DC.

Popular Name: Brussels Sprouts.

Description: Leaves slightly blistered. Along the stem from the axils of the leaves numerous small heads are produced.

(*d*) **B. oleracea,** Linn. var. **capitata,** Linn.

Popular Name: Red and White Cabbage.

Description: Leaves concave, not blistered, forming before flowering dense heads; stem abbreviated.

(*e*) **B. oleracea,** Linn. var. **gongylodes,** Linn.—*B. caulorapa,* Pasquale Catal Ort. Bot. Nap. (1867), 17. [Patwardhan Bull. 30 (1929), 4 Dept. Agr. Bombay, has '*caulocarpa' per errorem.*]

Popular Names: Knol-khol, Kohl-Rabi.

Description: Stem short, swollen and subglobosely thickened and fleshy at the base of the lower leaves.

(*f*) **B. oleracea,** Linn. var. **botrytis,** Linn. subvar. **cauliflora,** (Gars.) DC.—*B. cauliflora,* Garsault, Fig. Pl. Anim. Méd. (1764) t. 179, Descr. ii (1767), 123.

Popular Name: Cauliflower.

Description: Stem annual. Leaves oblong-ovate, light grey, often simple. Axes of racemes corymbosely congested before flowering, very fleshy and abbreviated, more or less covered with leaves.

2. **Brassica napus,** Linn. Sp. Pl. ed. 1, ii (1753), 666, n. 3 (*sensu ampl.*).—*Sinapis dichotoma,* Roxb. *ap.* Fleming Cat. Ind. Medic. Pl. in As. Res. xi (1810) no. 3, p. 179; Fl. Ind. iii (1832), 117.—*Brassica campestris,* Besser Enum.

Pl. Volhyn (1822), 72; Hook. f. & Th. Praecurs. ad Fl. Ind. in Journ. Linn. Soc. Bot. v (1861), 169, *non* Linn.—*B. campestris*, Linn. subsp. 1 *campestris et* subsp. 2 *napus*, Hook. f. & T. Anders. in Hook. f. F. B. I. i (1872), 156.—*B. campestris*, Linn. subs. *napus* var. *dichotoma et* var. *Toria*, Duthie and Fuller Field and Gard. Crops ii (1882-1893), 29.—*B. campestris*, Linn. subsp. A. *campestris* var. 2. *oleifera*, Prain in Agric. Ledger n. 1 (1898), 22, 45, t. iv *et B. napus*, Linn. var. *dichotoma*, Prain l. c. 36, t. viii, *et* subsp. B. *napus* var. 1. *oleifera* var. B. Prain l.c. 46.

Popular Name : Indian Rape.

Description : The whole plant glaucous. Root annual, fusiform, not thicker than the stem. Stem erect, 0·3–1·5 m. high, branching, pruinose, glabrous, below often violaceous; branches erect-patent. Basal leaves distinctly petiolate, lyrate-pinnatisect, terminal lobe the largest, ovate, rotundate at the apex, repand-crenate or-dentate, subtruncate at the base; lateral lobes smaller, ovate, the lowest minute, entire; the lower stem-leaves lyrate-pinnatifid, the upper gradually lanceolate, more or less entire, all dilated and amplexicaul at the base. Raceme at flowering time laxly corymbose, with flowers which don't surpass the flower-buds, later on very elongate, 25–40-flowered. Pedicels 1·2–2 cm. long. Sepals 6–8 mm. long, erect-patent, glabrous, yellowish, the outer ones narrow, obtuse, the inner broadly oblong. Petals yellow, 0·9–1·8 cm. long; lamina obovate, rounded or subemarginate at the apex, narrowed gradually into the claw. Inner stamens 7–10 mm. long, erect, outer ones 5–8·5 mm. long, ascending from the base; anthers oblong, 1·5–3 mm. long. Ovary 20–40-ovuled; style 1·5–2 mm. long. Pods erect-spreading on pedicels 0·8–3 cm. long, linear, curved in the upper part, 5–8·8 cm. long, sometimes shorter, subterete, 2·5–4 mm. diam., torulose with the beak flattened, 0- or 1-, rarely 2-seeded, 0·7–2·4 cm. long, sometimes longer, straw-coloured or purple; valves 1-nerved. Seeds globose, pendulous, 1–1·5 mm. diam., obscurely purple-brown, black near the hilum, minutely reticulate-alveolate.

I have not sufficient material for working out the varieties and forms cultivated in the Presidency.

3. **Brassica campestris,** Linn. Sp. Pl. ed. I, ii (1753), 666, n. 2; Smith and Sowerby Engl. Bot. xxxii (1811) t. 2234.—*B. campestris*, Linn. subsp. A. *campestris* var. 1. *agrestis*, Prain in Agric. Ledg. n. 1 (1898), 45.—*Crucifera rapa.* E. H. L. Krause in Sturm Fl. Deutschl. 2. ed. vi (1902), 137.—*Brassica colza*, Léveillé Monde Pl. xii (1910), 25, n. v.—*B. rapa*, Linn. subsp. *rapa*, Briquet Prodr. Fl. Corse ii, 1. (1913), 74.

Description : Root annual, thin. Stem 50–80 cm. high, rarely reaching 1·5 m., obtusely angular, branching, pruinose, mostly glabrous. Primary basal leaves distinctly stalked, the following ones more or less sessile, rarely distinctly stalked, lyrate-pinnatipartite, about 5-jugate: terminal lobe orbicular or ovate, obtuse at the apex, unequally denticulate, obliquely cordate at the base, lateral lobes alternating, shortly ovate, denticulate, gradually smaller and recurved; lower stem-leaves pinnatifid, but at the base very dilated and amplexicaul, the upper ones panduriform or lanceolate, deeply cordate at the base and amplexicaul, with the margin repand-denticulate or entire. Racemes at the flowering time densely corymbose, with the flowers surpassing the ovid flower-buds, later on very elongate, about 40-flowered. Pedicels 0·7–1 cm. long, filiform. Sepals 5 mm. long, erect-patent, yellowish green, the outer ones narrowly oblong, sometimes sparingly setulose, obtuse, the inner ones somewhat broader, rotundate. Petals yellow, 7·5 mm. long, limb obovate, subemarginate at the apex, cuneately narrowed at the base. Inner stamens 6·5 mm. long, erect, the outer ones 4·5 mm. long, ascending; anthers 1·8 mm. long. Ovary 20–24-ovuled; style 1 mm. long. Fruiting pedicels 1–3 cm. long, erect-patent or ascending. Pods erect, linear, 3·8–8 cm. long, 2–3 mm. diam., torulose, attenuate into a 0- or 1-seeded, 0·9–2·4 cm. long beak, yellow, with membranous valves. Seeds globose, pendulous, in the beak usually erect, 1·2–1·5 mm. diam., obscurely purplish brown, black near the hilum, reticulate-alveolate.

Originally indigenous in the hilly portions of the Mediterranean region.—The following variety is cultivated in the Bombay Presidency:

Brassica campestris, Linn. var. **rapa,** (Linn.) Hartm. Handb. Skand. Fl. ed. 6 (1854), 110, subvar. **depressa,** (DC.) O. E. Schulz.—*Rapa rotunda*, Miller Dict.

ed. 8 (1768) n. 1.—*Brassica rapa*, Linn. Sp. Pl. ed. 1. ii (1753), 666, n. 4 var. *depressa*, DC. Syst. Nat. ii (1821), 590, *et* Prodr. i (1824), 214.—*B. campestris*, Linn. subsp. C. *rapa* var. *esculenta* 2. *depressa*, Prain in Agr. Ledg. n. 1 (1898), 46.

Popular Name : Turnip, Shalgam.
Description : Root thickened, spherical or depressed, below suddenly contracted into a thin rootlet.

4. **Brassica juncea**, (Linn.) Czerrn. & Coss.; Czern. Consp. pl. Chark (1859), 8, n. V; Coss. Append. Florul. Juven. in Bull. Soc. Bot. France vi (1659), 609; Hook. f. and Th. Praecurs. Fl. Ind. in Journ. Linn. Soc. Bot. v (1861), 170 (*partim*); Hook. f. and T. Anders, in Hook. f. F. B. I. i (1872), *partim*. *Sinapis juncea*, Linn. Sp. Pl. ed. 1. ii (1753), 668 (*excl. syn.* Herm.).—*S. ramosa*, Roxb. *ap.* Fleming in Asiat. Res. xi, 3 (1819), 179 *et* Fl. Ind. iii (1832), 119.—*Brassica juncea* subsp. A. *juncea* var. 2. *oleifera*, Prain in Agric. Ledg. n. (1898), 47, t. iii.
Popular Names : Indian Mustard, Rai, Mohari.
Description : An annual herb. Stem 0·3–0·8 m. high, long-branched from the middle, rarely simple, pruinose, glabrous or with a few soft white hairs at the base; branches erect-patent. Lower leaves distinctly stalked, lyrate-pennatisect, 2-3-jugate; terminal lobe largest, ovate, more or less truncate at the base, margin irregularly and coarsely dentate; lateral lobes ovate, dentate, the lowest minute; middle leaves more or less simple, oblong-ovate, dentate; the upper leaves oblong-linear, acute, narrowed at the base into a short petiole, entire. Raceme during flowering rather lax, then more so, 20–40-flowered. Pedicels 5–8 mm. long. Sepals 4-6 mm. long, erect-patent, the outer ones narrowly oblong, rotund at the apex, the inner ones oblong, glabrous. Petals bright yellow, 6–9·5 mm. long; blade obovate, rounded at the apex, suddenly contracted into the claw. Inner stamens 5·5–8·5 mm. long, outer ones 4-7 mm. long; anthers oblong, obtuse, 1·8-2·5 mm. long. Ovary 12–20-ovuled, narrowed into a thin, 2–2·5 mm. long style; stigma capitate, broader than the style. Fruiting pedicels erect-patent. Pods suberect or erect-spreading, linear, 3·2–5·6 cm. long, 2–3·5 mm. broad, subtetragonous, torulose, gradually narrowed into a 6–12 mm. long thin, seedles beak; valves yellowish. Seeds globose, 1·3 mm. diam., obscurely purplish brown, alveolate.
Prain and following him O. E. Schulz mention 3 varieties from British India, all of which seem to be cultivated in the Bombay Presidency:
Var. β. **elata**, (Prain) O. E. Schulz in Engl. Pflanzenr. iv, 105 (1919), 56.—*B. juncea*, Hook. f. & Th. subsp. A. *juncea*, (Linn.) var. 2. *oleifera*, Prain subproles 1. *elata*, Prain in Agric. Ledg. n. 1. (1898), 47.
Description : Stem 1·5–1·8 mm. high. Lower leaves sparingly hispid underneath.
Var. γ. **aspera**, (Prain) O. E. Schulz l. c.—*B. juncea*, Hook. f. & Th. subsp. A. *juncea*, (Linn.) var. 2. *oleifera*, Prain subprol. 2. *aspera*, Prain l.c.
Description : Stem 0·9–1·2 high. Leaves more or less hispid underneath.
Var. δ **laevis**, (Prain) O. E. Schulz. l. c.—*B. juncea*, Hook. f. & Th. subsp. A. *juncea*, (Linn.) var. 2. *oleifera*, Prain subprol. 3. *laevis*, Prain l. c.
Description : Stem 0·9–1·2 m. high, obscurely purple. Lower leaves quite glabrous.

5. **Brassica nigra**, (Linn.) Koch in Röhling's Deutschl. Fl. ed. 3. iv (1833), 713 *et* Syn. ed. 1 (1835), 59; Boiss. Fl. Or. i (1867), 390; Hook. f. & T. Anders. in Hook. f. F. B. I. i (1872), 156.—*Sinapis nigra*, Linn. Sp. Pl. ed. 1. ii (1753), 668.—*Sinapis erysimoides*, Roxb. Hort. Beng. (1844), 48 (*nomen*) *et* Fl. Ind. iii (1832), 123 (*descript.*); DC. Syst. Not. ii (1821), 625.
Popular Names : Black Mustard, Rai, Mohari, Sasivi.
Description : Root annual. Stem erect, 0·5–1·3 m. high, mostly branching from the middle, more or less hispid, often purple-spotted or purplish in sunny places. Branches thin, divaricate and ascending, virgate. Lower leaves distinctly stalked, lyrate-pinnatisect; terminal lobe the largest, ovate, often 5-lobed, on the margin unequally callose-denticulate, at the base more or less hastate; lateral lobes much smaller, obovate or oblong, denticulate, the lowest extremely small: middle leaves shorter-petioled; the upper leaves oblong-linear, narrowed at the base into a short petiole, mostly entire, often pendulous; all very membranous and bright green. Raceme at flowering time corymbose, but

the flowers not surpassing the buds, then very elongate, 40–60-flowered. Pedicels very short, 2–3 mm. long, glabrous. Sepals 4–5 mm. long, oblong, erect-patent, glabrous. Petals yellow, 7·5–9 mm. long; blade obovate, at the apex truncate and undulate, cuneately narrowed at the base into a thin claw. Inner stamens 6 mm. long, the outer 5 mm.; anthers oblong, obtuse, 1·5 mm. long. Ovary 7-11-ovuled; style 1–2 mm. long; stigma distinctly broader than the style. Fruiting pedicel 2·5–4·5 mm. long, erect. Pods small, 1–2 cm. long, 1·5–2 mm. diam., linear, subtetragonous, torulose; beak 1·5–2·5 mm. long, thin, seedless; valves 1-nerved with lateral nerves very thin, straw-coloured, rarely purplish. Seeds globose, 1 mm. diam., obscurely brown, black near the hilum, delicately alveolate.

Distribution: Central Europe, Macaronesian transition area and Mediterranean region.—Cultivated in the Presidency.

For a more complete treatment of the system and genetics of the Brassicas see:

Bailey, L. H.—The cultivated Brassicas. Gentes Herbarum 1 (1922), 53–108.

Baumann, E.—Beiträge. zur Kenntnis der Rapspflanze und zur Züchtung des Rapses. Zeitschr. Pflanzenzüchtung 6 (1918), 139.

Becker, J.—Beiträge zur Züchtung der Kohlgewächse. Zeitschr. Pflanzenzüchtung 7 (1919), 91–99.

Hallquist, C.—Brassicakreuzungen. Bot. Not. (1915), 97–112.

Brassica crosses. Gard. Chron. 67 (1920), 10.

SINAPIS, Linn. Sp. Pl. ed. 1. ii (1753), 668 (*partim*).

Sinapis alba, Linn. Sp. Pl. ed 1. ii (1753), 668; Sowerby Engl. Bot. xxiv (1806), t. 1677; DC. Syst. Nat. ii (1821), 620 *et* Prodr. i (1824), 220; Schulz in Engl. Pflanzenr. iv, 105 (1919), 129.—*Brassica alba,* Rabenh. Fl. lus. i (1839), 184; Boiss. Voy. Bot. Midi de l'Esp. ii (1839–45), 39; Hook. f. and T. Anders. in Hook. f. F. B. I. i (1872), 157.

Popular Name: White Mustard.

Description: Root annual. Stem 0·25–0·65, rarely 1 m. high, erect, acutely angled, more or less branched from the base or upwards, covered below with recurved hairs 0·5–1 mm. long, above with scattered hairs, often purplish at the base; branches erect-patent. Lower leaves on a hispid 2·5–3 cm. long petiole, lyrate-pinnati-partite, 2–3-jugate; terminal lobe broadly ovate, obtuse, trifid; upper leaves stalked, all very membranous, pilose on both sides, rarely glabrous, bright green, sometimes purple-spotted. Raceme 35-50-, rarely up to 100-flowered. Pedicels 5–8 mm. long, patent at almost a right angle, glabrous or with scattered hairs. Sepals 4·5–6 mm. long, the outer oblong, rounded at the apex, the inner oblong-ovate, glabrous or sparingly pilose, horizontally spreading. Petals yellow, 7-9·5, rarely up to 12 mm. long; blade broadly obovate, few-veined, suddenly contracted into a thin claw. Inner stamens longer than the outer. Ovary very short, 1·5–2 mm. long, densely pilose, 4–8-ovuled; style first pilose, then glabrescent; stigma subbilobed. Fruiting pedicels patent more or less at a right angle, 0·6–1·2 cm. long. Pod spreading or ascending, broadly cylindric, 2–3·7 cm. long, 3–4 mm. diam., torulose, hispid; beak compressed, ensiform, often curved upwards, less pilose, greenish, longitudinally nerved, mostly seedless, rarely 1–2-seeded, 1–2·7 cm. long; valves boat-shaped, with 3 or 5 stout nerves, yellow. Seeds globose, 1·5–2 mm. diam., pale yellow, testa minutely alveolate.

Indigenous in the Mediterranean and Macaronesian regions. Elsewhere cultivated.

RAPHANUS, Linn. Sp. Pl. ed. 1. ii (1753), 669.

Species 8, chiefly in the Mediterranean region.—2 species cultivated in the Bombay Presidency.

1. Petals 1·7–2·2 cm. long; ovules 10–12; pods 3–9 cm. ... ... 1. *R. sativus.*
2. Petals 2·6 cm. long; ovules 14–21; pods 20–60 cm. long or longer ... ... 2. *R. caudatus.*

1. **Raphanus sativus,** Linn. Sp. Pl. ed. 1. ii (1753), 669 (*γ. chinensis annuus oleifer*), ed. 2. ii (1763), 935; Schulz in Engler's Pflanzenr. iv, 105 (1919), 205.

Popular Names : Radish, Mula, Mulangi, Muri.

Description : Root annual, stem 0·2–1 m. high, flexuose, fistular, branched in the upper part, glabrous or hispid, often purple. Lower leaves on hairy petioles 5·5–8 cm. long, lyrate-pinnatifid, 3–4–, rarely 5–jugate; terminal lobe suborbicular or shortly ovate, rounded at the apex, with the margin repand-crenate, subcordate at the base or more or less confluent with the lateral lobes; lateral lobes alternate, oblong-ovate, obtuse, dentate or subentire; upper leaves shorter-petiolate, 2–1–jugate, terminal lobe oblong-ovate, margin coarsely dentate; uppermost leaves simple, sublinear, but narrowed at the base; all roughly pilose, bright green, often obscurely red-margined, often also red-nerved. Raceme lax, 8–30–, rarely up to 55–flowered. Pedicels 2–1 cm. long, with scattered hairs. Flowers scented. Sepals 6·5–10 mm. long, oblong, sometimes brown-red. Petals 1·72–2 cm. long; blade obovate, subemarginate at the apex, white or lilac with yellow or purple veins. Ovary green or brown-purple, 10–12–ovuled; style about 4 mm. long. Fruiting pedicel 2·2–1 cm., rarely up to 3·5 cm. long, erect-patent or ascending. Pods erect, cylindric, 3–9 cm. long, 0·8–1·4 cm. diam., continuous or more or less constricted, longitudinally sulcate-nervose, yellow, rarely quite pale purple, beak green. Seeds sessile, pendulous, ovoid, light brown, testa reticulate.

Two principal kinds are grown in the Presidency:

(*a*) Prol. **radicula**, Pers. Syn. ii (1807), 208; (*B. oblonga*) DC. Syst. ii (1821), 664 *et* Prodr. i (1824), 228.

Popular Name : The long-rooted radish.

Description : Root mostly annual, thickened, fusiform or oblong or globose or ovoid, small, 3–10 cm. long.

(*b*) Prol. **niger**, Pers. Syn. ii (1807), 208; (*a vulgaris*) DC. Syst. ii (1821). 665 *et* Prodr. i (1824), 228.

Popular Name : The turnip-rooted radish.

Description : Root usually biennial, very much thickened, oblong, 10–20 cm. long.

2. **Raphanus caudatus,** Linn. Mantiss. i (1767), 95; Linn. f. Plant. rar. Horti Upsal. dec. iii (1767), 19, t. 10.—*R. raphanistrum,* Linn. subsp. *caudatus,* Thell. in Hegi Ill. Fl. Mitt. Eur. iv, 38 (1918), 275, fig. 790g.

Popular Name : Rat-tailed radish, Mogari.

Description : It differs in the following points from *R. sativus :* Root annual, fusiform. Stem 0·6–0·9 m. high, first erect, then prostrate. Flowering pedicels 2·5–1 cm. long. Sepals 10–12·5 mm. long. Petals 2·6 cm. long. Ovary 14–21–ovuled. Fruiting pedicels 4–1·8 cm. long, patent. Pods ascending or declinate, very elongate, cylindric, long-beaked, often serpentiform, 20–60 cm. long, at the base 1·5–2·5 cm. diam., often longer than the whole plant, fleshy, yellow or pale purple or dark red. Seeds distant.

This species is considered by some as a variety of *R. sativus,* by others as a monstrous form of *R. sativus* cultivated in tropical gardens.

PHYSORRHYNCHUS, Hook. Ic. Pl. 2. ser. v (1852) t. 821 *et* 822;
Cke. i, 34.
(*Physorhyncus,* Hook. f. & T. Anders. in Hook. f. F. B. I. i (1872),
165, *sphalm.*)

Species 2.—S. Persia, Afghanistan, Baluchistan, Sind, Punjab.—Only 1 in the Bombay Presidency, of which a more complete description is given here in order to facilitate the distinction between the two species.

1. **Physorrhynchus brahuicus**, Hook. Ic. Pl. 2. ser. v (1852) t. 821 *et* 822; Aitchis. in Journ. Linn. Soc. Bot. viii (1865), 59; Boiss. Fl. Or. i (1867), 403 (*partim*); Hook. f. & T. Anders. in Hook. f. F. B. I. i (1872), 165 (*excl. P. chamaerapistrum*); Cke. i, 34; Schulz in Engler's Pflanzenr. iv, 105 (1923), 34 fig. 2D, 10F.

Description : A glabrous glaucous undershrub, 0·6–1 m. high. Stem branching, flexuose; branches erect-patent, elongate, virgate. Lower leaves obovate, obtuse at the apex, repand-dentate on the margins, cuneately narrowed at the base into a short petiole, about 5 cm. long and 4 cm. broad; upper leaves gradually smaller, ovate or oblong, entire, semiamplexicaul at the base and biauriculate; all fleshy, thick, coriaceous when dry. Racemes very lax, later elongate, virgate, 12–25–flowered. Pedicels short, 4 mm. long, suberect. Spaels erect, 7–8 mm. long, outer ones narrowly linear, narrowed at the apex

and cucullate, inner ones broadly lanceolate, subsaccate at the base, all pale green, narrowly hyaline-margined. Petals white, 1·5 cm. long; blade narrowly elliptic, rounded at the apex, densely veined, gradually narrowed into a subfiliform claw. Stamens 6–8 mm.; anthers sublinear, acute, 3 mm. long. Median nectariferous glands long-stipitate, the lateral ones scale-like. Ovary subulate, biarticulate; lower joint terete, 1·5 mm. long, empty; the upper joint twice as long, inflated at the base, 4-ovuled, above narrowed into the style; stigma bilobed at the apex. Fruiting pedicels 5–4 mm. long, erect. Pods appressed to the axis, biarticulate, 1–1·8 cm. long, with a strong septum; lower joint stipitiform, narrowly obconic or turbinate, 2·5–3 mm. long, 1 mm. diam. below, bivalved, valves sublinear, obtuse at the apex, 1-nerved, carinate, bilocular, empty; upper joint closed, ovoid, 4–6 mm. broad, coriaceous, bilocular, each loculus 2-seeded; beak conical, subtetragonous. Seeds pendulous, shortly ellipsoid, 2 mm. long, 1·5 mm. broad; testa very minutely reticulate.

Locality: Sind: Thano-Bula-Khan, Soorjana Hills, 1,800 ft. (Ticehurst 30,872 ! 30,875 !); Laki Hill in Larkana (Ticehurst 28,116 !); Brahuve Hills (Stocks).

Distribution: Punjab, Baluchistan, Afghanistan.

PITTOSPORACEÆ (Cke. i, 57).

Genera 9; species about 105.—Warmer regions of the Old World. Absent from America.

PITTOSPORUM, Banks ex Gaertn. Fruct. i, (1788), 286, t. 59 (Cke. i, 57).

Species about 70.—2 species occur in the Bombay Presidency: *P. floribundum* and *P. dasycaulom*. The first name has to cede to *P. nepaulense* as is evident from the following synonymy:

1. **Pittosporum nepaulense,** Rehder & Wilson in Sargent Pl. Wils. iii, (1916), 326.—*Senacia nepaulensis*, DC. Prodr. i, (1824), 347.—*Pittosporum floribundum*, W. & A. Prodr. (1834) 154; Hook. f. and Thoms. in Hook. f. F.B.I. i, 199; Cke. i, 58; Gamble Ind. Tim. (1902), 43; Fl. Madras (1915), 55; Talbot For. Fl. Bomb. i, (1909), 81; Haines Bot. Bih. and Or. (1921), 39.—*Celastrus verticillata*, Roxb. Fl. Ind. i (1832), 624.

Description: Cke. i, 58.

Distribution: Subtropical Himalayas, Khasia Hills, Mishmis, Burma, W. & S. India.

2. **Pittosporum dasycaulon,** Miq.

Distribution: According to Talbot this tree seems to be 'endemic in the southern Ghat forests of Bombay.' But it is also found in the Shola forests, above 3,000 ft., from Mysore to Travancore (Gamble).

POLYGALACEÆ (Cke. i, 58).

Of the 15 genera only 2 are represented in the Presidency: *Polygala* and *Xanthophyllum*, the latter not mentioned by Cooke.

1. Herbs or shrubs ... ... *Polygala.*
2. Trees ... ... *Xanthophyllum.*

1. POLYGALA, Linn.

I add only a few notes:

1. **Polygala persicariaefolia** DC.—Flowers at Panchgani rose or white.

Distribution: Tropical Africa, India, Yunnan, Siam, Philippines, N. Guinea, Australia.

2. **Polygala erioptera,** DC.—Add localities: Khandala, Poona, Pasarni Ghat, Panchgani.

4. **Polygala chinensia,** Linn.—Lateral petal and keel pale yellow, the former with brownish markings at base; crest bright yellow.—Cooke says that the capsule is strongly ciliate; I have sometimes found them very slightly ciliate.

Distribution: India, Indo-China, Siam, Philippines.

Var. **triflora,** (Linn.) Bennett in Hook. f. F.B.I. i, 204.—*Polygala triflora*, Linn. Sp. Pl. 705.

Locality: S. M. Country: Badami.

5. **Polygala irregularis,** Boiss.—Wings usually rose,

2. Xanthophyllum, Roxb.

Gagnepain tried to separate this genus as a distinct family from the *Polygalaceæ*. In spite of its regular flowers and of other differences of generic importance, its close relationship with the ***Polygalaceæ*** is shown by the relation of its floral parts and by the form of its pollen. [See B. Jauch. Quelques points de l'anatomie et de la biologie des Polygalacées. Bull. Soc. Bot. Genève 10 (1918), 47–84.]

Large trees. Leaves large, simple, alternate, coriaceous, often yellowish green. Flowers in racemes or panicles. Sepals 5, somewhat unequal. Petals 4–5, nearly equal, declinate, the keel-petal boat-shaped, not crested. Stamens 8, 2 hypogynous, the remainder adnate to the base of the petals. Ovary 1-celled or imperfectly 2-celled, stipitate; ovules 4–16, variously attached. Style elongate. Fruit 1-celled, indehiscent, 1-seeded. Seeds exalbuminous, estrophiolate; cotyledons thick and fleshy, radicle short.

Species about 45.—India, Malaya, Australia.

1. **Xanthophyllum bombayanum,** Chodat in Bull. Herb. Boise. iv, 263.

Description: Leaves broadly elliptic, acute, secondary nerves ascending, 12 by 6 cm. or smaller, glabrous, shining. Rhachis of raceme stout. Sepals subequal, pubescent, slightly subacute. Corolla 11 mm. long, purple or fuscous. Stamens almost free, pilose at the base and united with the petals. Ovary stipitate, like the style very pilose. Fruit broadly ovate, subapiculate, rugose with warts arranged in longitudinal series, 38 mm. broad, pericarp 1·7 mm. thick.

Locality: 'Ad Bombay', (Herb. Kew ex Bull. Herb. Boiss., collector not known).

Distribution: Apparently endemic.

FRANKENIACEÆ (not in Cke.).

Low herbs or undershrubs, much branched and jointed at the nodes. Leaves opposite, small, exstipulate, often clustered in the axils. Flowers usually pink or purple, sessile in the forks of the branches, forming a more or less dense terminal leafy cyme, sometimes contracted into a globular head, regular, hermaphrodite. Calyx tubular, gamosepalous, persistent with 4, 5, or rarely 6 lobes, valvate in bud, with as many prominent angles and furrows. Petals 4–6, hypogynous, imbricate in bud, free, the claws with an adherent scale on the inner face, lamina spreading. Stamens usually 6, sometimes 4 or 5 or indefinite, hypogynous, free or shortly united in a ring at the base, filaments filiform or flattened; anthers versatile, 2-celled. Ovary free, sessile, 1-celled, with 3, rarely 2 or 4 parietal placentas, or very rarely a single one. Style filiform, with as many branches as placentas, the stigmas capitate or oblique. Ovules several, or rarely solitary, to each placenta, attached to rather long ascending funicles, amphitropous or nearly anatropous, with an inferior micropyle. Capsule enclosed in the persistent calyx, opening by as many valves as there are placentas. Seeds ovoid or oblong, testa crustaceous, the hilum almost terminal. Embryo straight, in a mealy albumen, the radicle next the hilum, shorter than or as long as the cotyledons.

Genus 1.

1 Frankenia, Linn. Gen. ed. 1 (1737), 129.

Characters of the family.—Species about 50 (See paper read by V. Summer Hayes at the General Meeting of the Linnean Soc. London, 1st Nov. 1928.)

Distribution: Old and New world, natives of dry sandy and especially saline tracts.

1. **Frankenia pulverulenta,** Linn. Sp. Pl. I (1753), 332; Boiss. Fl. Or. i, 779; Lam. Illustr. tab. 262; DC. Prodr. i, 349; Edgeworth in Hook. f. F.B.I. i, 212.

Description: A diffuse or procumbent, much-forking herb, 10-20 cm. high. Leaves opposite, obovate, oval or rotundate, often fascicled, usually mealy-puberulous or setulose or setulose-pubescent beneath, flattish or with the margins more or less recurved, narrowed into short ciliolate or nearly glabrous petioles, less than 4 mm. in length. Calyx tubular, with short acute teeth, equalling the leaves. Filaments membranous, dilated, tapering above and below.

Locality: Sind, on Sola land (Edgeworth, Agharkar). Mr. C. E. C. Fischer informs me that there is no specimen from Sind in the Kew Herb.

Distribution: Mediterranean region, Arabia, Mesopotamia, Persia, Baluchistan, Senegal, Cape.

CARYOPHYLLACEAE.

About 1,300 species.

DIANTHUS, Linn.

Not represented in the Presidency by any indigenous species. But the following are often cultivated:

1. **Dianthus Caryophyllus**, Linn. Sp. Pl. 410.

Popular Names: Wild Carnation, Clove Pink.

Description: A herbaceous perennial, erect, smooth, bluish green, stout, much-branched, leafy below. The barren stems are long, prostrate, then ascending, branched. Leaves channelled above, bent-back, linear, margins smooth. Flowers pink, fragrant, in loosely panicled cymes. Bracts obovate, obtuse-acute, $\frac{1}{3}$ - $\frac{1}{4}$ the length of the calyx-tube. Calyx cylindric, obscurely ribbed, the teeth not fringed with hairs, longer than the capsule. Petals scalloped, toothed, obovate, smooth, the teeth $\frac{1}{8}$ - $\frac{1}{4}$ the length of the blade. Capsule ovoid. Seeds pear-shaped, nearly flat.

Locality: Thrives freely at Mahableshwar and Panchgani, blooms occasionally at Poona.

Distribution: Generally supposed to be a native of the Mediterranean region.

2. **Dianthus chinensis**, Linn. Sp. Pl. 411.

Popular Name: The China Pink.

Description: Cespitose, glabrous, more or less creeping at the base. Stem forking, angled and more or less grooved, pubescent. Leaves broad and nearly flat or slightly trough-shaped, 3-5-nerved. Flowers large, solitary or more or less clustered, pink or lilac. Bracts leafy and spreading, 4, in some cultivated varieties short.

Distribution: China, Japan. Some consider a European Pink to be a form of it and have, therefore, to extend its range to Portugal.

STELLARIA, Linn. (Cke. I, 64).

1. **Stellaria media**, Cyrill. Charac. Comm. (1784), 36.

Cke. I, 64 identifies this species with *S. media*, Linn. in Hook. f. F.B.I. i. 230. I have not been able to find that the name *Stellaria media* has been used by Linnæus. He described the same plant under *Alsine media*, Linn. Sp. Pl. ed. i, 222. Edgeworth. and Hook. f. seem to be the first to make the combination *Stellaria media*, Linn. and many others have followed them.

In addition, *Stellaria media*, Edgew. & Hook. f. *l. c.* includes 2 distinct species: *Stellaria media*, Cyrill. and *Stellaria Wallichiana*, Haines in Kew Bull. (1920), 66 which is *Alsinella Wallichiana*, Benth. in Wall. Cat. 630.

The synonymy of *Stellaria media* Cyrill. is therefore: *Stellaria media*, Edgew. & Hook. f. in Hook. f. F.B.I. i, 230 (*partim*).—*Alsine media*, Linn. *l. c.*

Description: A small diffuse annual herb with a line of hairs down one side of the stem and branches. Leaves rather flaccid, ovate, 12-25 mm. long, with rounded rarely subcordate base, lower ones long-petioled, upper sessile elliptic and narrower. Flowers numerous, white, in irregularly forked leafy cymes small, on rather long slender pedicels. Sepals lanceolate, subobtuse, hairy or glandular, margins scarious. Petals 5 or 0, 2-fid to the base, Stamens 3, 5 or 10. Capsule ovoid-cylindric, longer than the sepals. Seeds brown, obtusely tubercled.

[The allied species *Stellaria Wallichiana*, Haines, differs from *S. media* by having 4 sepals, and petals, by the sepals having no scarious margin, by the petals being rather emarginate than 2-fid, by all the leaves being stalked and by the seeds being acutely tubercled.]

Locality: W. Ghats: Mahableshwar and Panchgani, probably introduced.

POLYCARPON, Lœfl. It. (1758), 7; Linn. Syst. ed. x (1759), 881. (Cke. i, 65).

Cooke has 1 species: *P Læflingiae*, Benth. & Hooker which should be called:

Polycarpon indicum, Merrill in Philipp. Journ. Sc. Bot. x (1905), 302.—*Læflingia indica*, Retz. Obs. iv (1786), 38.—*Polycarpon Læflingi*, Benth. & Hook,

f. Gen. Pl. i (1862), 153, *in nota* (*Læflingii*); Edgew. & Hook. f. in Hook. f. F.B.I. i, 245.—*Hapalosia Læflingi*, Wall. Cat. 6962 *ex* Wight & Arn. Prodr. i (1834), 358.—*Arversia Læflingiae*, Walp. Rep. i (1842), 263.
Distribution : Hotter parts of India, Indo-China, tropical Africa.

POLYCARPEA, Lam. in Journ. Hist. Nat. Par. II, (1792), 1. (*Polycarpea*, Lam. l. c. p. 8). Cke. i, 66.

1. **Polycarpea corymbosa**, Lam. Ill. ii (1793), 129; Tab. Encyc. et Method. ii (1800), 129.
Locality : Add : W. Khandesh (Blatter and Hallberg !).—*Deccan :* Deolali (Blatter !).
The var. *aurea* given in the F. B. I. i, 245 and Cke. i, 66 was restituted by Gamble (Madras Fl. 65) to the rank of species.

2. **Polycarpea aurea**, W. & A. in Ann. Nat. Hist. ser. 1, iii (1839), 91; Gamble Fl. Madras (1915), 65.—*P. corymbosa* var. *aurea*, Wight Ill. ii, 44, t. 110; Edgew. and Hook. f. in Hook. f. F. B. I. ii, 245; Cke. i, 66.
Description : A much-branched shrub of rock crevices. Branches hoary-tomentose. Leaves subulate, not forming rosettes, with inrolled margins, in axils few or 0. Stipules hardly fimbriate, about 1 mm. long. Internodes densely white-tomentose. Flowers in irregular cymes, smaller than in *P. corymbosa*, orange or brownish red. Sepals coloured, 2·5 mm. long.
Distribution : Rocky places in the Deccan Hills of the Madras Presidency : Guntur, Kurnool, Bellary, Cuddapah, N. Arcot, Chingleput, at 2,000 to 4,000 ft. (Gamble).

3. **Polycarpea spicata**, W. & A.
Locality : Add : *Kathiawar :* Dwarka, on dry flats, better developed on sand (*ex* Börgesen).

PORTULACACEÆ (Cke. i, 67).

PORTULACA, Linn. (Cke. i, 68).

2. **Portulaca Wightiana**, Wall, Cat. (1828), 6845.
Distribution : Southern Districts of the Bombay Presidency. *Madras Pres. :* Dry districts of the Deccan and Carnatic from the Godavari southwards usually on rocks and up to 2,500 ft. (Gamble), Ceylon.

3. **Portulaca quadrifida**, Linn. Mant. (1767), 73.
Locality : Add : *Kathiawar :* Dwarka (Börgesen).—*West Khandesh* (Blatter !).—*Konkan :* Bombay (Blatter !)
Distribution : W. Rajputana, in the desert (Blatter & Hallberg !). Sind, Kathiawar, Konkan, Deccan, S. M. Country, most districts of the Madras Pres., all over India, tropical Asia and Africa.
Note : The flowers only open in bright sunshine like others of the genus (Haines).

4. **Portulaca tuberosa**, Roxb. Hort. Beng. (1814), 91.
Locality : Add : *Gujarat :* Ahmedabad (Blatter !).
Distribution : Sind, Gujarat, dry Districts of the S. Carnatic from S. Arcot to Travancore (Gamble), Ceylon.

5. **Portulaca suffruticosa**, Wight in Wall. Cat. (1828), 6842.
Distribution : Gujarat, Carnatic districts from Coimbatore and S. Arcot to Travancore, up to 3,500 ft. (Gamble).

TAMARICACEÆ (Cke. i, 70).

TAMARIX Linn. (Cke. i, 70).

Cooke describes 5 species : *T. gallica* var. *indica*, *T. dioica*, *T. articulata*, *T. ericoides*, *T. sticta*. Hole has shown that the plant hitherto known from India as *T. gallica*, Linn. is a new species. The true *T. gallica* does not seem to occur in India. *T. articulata*, Vahl has to be changed into *T. aphylla* Lanza.

1. **Tamarix Troupii**, Hole in Ind. For. XLV (1919), 247; Troup Silvic. Ind. Trees i, 16.—*T. gallica*, Dyer in Hook. f. F. B. I. i, 248, Cke. i, 70. *et multorum auctorum quoad species e* Punjab, Sind, United Provinces, Mt. Abu, Bombay Presidency.
Locality : Add : W. Khandesh (Blatter !).
Distribution : United Provinces, Mt. Abu (Blatter and Hallberg !), Punjab, Sind, Baluchistan.

2. **Tamarix dioica**, Roxb. Hort. Beng. (1814), 22; This.-Dyer in Hook. f. F. B. I. i, 249; W. and A. Prodr. 40; Boiss. Fl. Or. I, 777; Brandis For. Fl. t. 6; Cke. i, 71; *T. gallica*, Wight iii. i, t. 24A (*non* Linn.)—*T. articulata*, Wall. Cat. 3756 (*ex* F. B. I., *non* Vahl.)

Description: Cke. i, 71.

Locality: Add: W. Khandesh (Blatter and Hallberg!); *Konkan*: Bombay (Blatter!).

Distribution: 'Throughout N. India up to 2,500 ft. in the outer Himalayan valleys, Sind, the Peninsula of India, Bengal, Assam, Santal Parganas, and in the dry zone of Burma. It is common along the Ganges, Hooghly, and other rivers, and forms extensive forests along the Indus in Sind. It is also found along the sea-coast.' (Troup). We found it at Mt. Abu. In the Madras Presidency it is found in sandy river-beds and on the sea-coast, but is apparently very scarce (Gamble).

3. **Tamarix aphylla**. Lanza in Boll. Orto Bot. Palermo viii (1909), 82; Blatter Fl. Arab. (1919), 72.—*Thuya aphylla*, Linn. Cent. Pl. i, 32; Amoen. Acad. iv, 295.—*Tamarix articulata*, Vahl. Symb. Bot. ii (1791), 48, t. 32; DC. Prodr. iii, 96; Bunge Tent. Tamaric. (1852) n. 44; Boiss. Fl. Or. i (1867), 777; This.-Dyer in Hook. f. F. B. I. i, 249; Cke. i, 71.—*T. orientalis*, Forsk. Fl. Aeg. Arab. (1775), 206.—*T. orientalis*, Linn. in Troup. Silvic. i, 18 *quid est?*

Locality: Add: Cutch (Blatter!).

Distribution: Punjab plains, Sind, Cutch, Baluchistan, Persia, Mesopotamia, Arabia, Mediterranean region, S. Africa.

4. **Tamarix ericoides**, Rottl. in Gesel. Naturf. Fr. Berlin Neue Schr. iv (1803) 214.

Locality: Add: W. Khandesh (Blatter!).

Distribution: Mt. Abu, W. Peninsula, Bengal, Chota Nagpur, Circars, Deccan, C. Carnatic, and S. India, Ceylon.

(*To be continued.*)

THE PANTHERS AND OUNCES OF ASIA.

BY

R. I. Pocock, F.R.S.

Temporary Assistant in the Zoological Department of the Natural History Museum.

(With Plates VII-XIII)

(Continued from page 82 of this volume)

Part II.

The Panthers of Kashmir, India and Ceylon.

Panthera pardus fusca, Meyer.

(Pls. II, III and VII).

Felis fusca, Meyer, *Zoolog. Annalen,* I, p. 394, 1794, based upon De la Métherie's figure and description of a black panther from Bengal in the Tower of London (*Journ. de Physique,* 33, *p.* 45, Pl. II, 1788).

Felis longicaudata, Valenciennes, *C.R. Acad. Sci. Paris,* 42, p. 1036, 1856 (preoccupied).

Panthera antiquorum, Fitzinger, *SB. Akad. Wiss. Wien,* 58, p. 47, 1868; *Felis pardus antiquorum,* Matschie, *SB. Nat. Fr. Berlin,* 1895, p. 194 (Not *Felis pardus antiquorum,* J. E. Grey, 1827).

Felis pardus pardus (by implication), Dollman after Lydekker, *Game Animals of India,* p. 314, 1924; Rowland Ward's Records, p. 482, 1928.

Type locality.—Bengal. Type probably not in existence.

Distribution.—India from the Himalayas to Cape Comorin; Ceylon; range to the east of the Bay of Bengal uncertain.

Notes on the synonymy.—It is unfortunate that the earliest name definitely assigned to an Indian panther was given to a melanistic variety which was therefore called *fusca.* The animal was recorded as coming from Bengal; and since skins from that district agree with those from other parts of India, I have no choice but to adopt *fusca* as the racial name at all events of the dominant type of panther of the country.

With regard to *longicaudata,* Valenciennes stated that F. Cuvier gave that name to an alleged long-tailed leopard from Ceylon and the Malabar coast of India. But I cannot trace it in F. Cuvier's works. Probably it was a MS. name which Valenciennes adopted.

But in any case it is inadmissible, being preoccupied by *Felis longicaudata* employed by Blainville in 1840 for one of the small Felidæ of the *marmorata* type.

Another name that has been frequently assigned to the Indian panther is *antiquorum*. There are probably few names of mammals about which more mistakes have been made. Under the title 'Panther of the Ancients', it was first mentioned by Griffith who described and illustrated the animal from MS. notes and a figure prepared by Hamilton Smith from a specimen he saw in the Hesse Cassel Museum (Griffith's *Animal Kingdom*, ii, p. 466, Pl. 1827). J. E. Gray gave the technical name *antiquorum* to this panther (Griffith's *Animal Kingdom*, v, p. 165, 1927.)[1] The animal was imported alive and was exhibited in the menagerie of the Elector of Hanover; but its locality was, and is, unknown.

Sykes (*Proc. Zool. Soc.*, 1831, p. 102) was responsible for assigning the name *antiquorum* to the so-called panther of the Deccan known to the Mahrattas as 'Beebeea Baugh', declaring that this animal 'exactly resembles' the one figured and described by Griffith as 'The Panther of the Ancients'. This he diagnosed as smaller, darker in colour and with more crowded rose rings than the leopard (*F. leopardus*) of the Deccan, the cheetah of the Mahrattas, which he regarded as a distinct species. But Hamilton Smith's figure most emphatically represents a panther with large, almost 'jaguarine' well-spaced rosettes and in his description of the specimen he drew particular attention to the buff-yellow tint of the flanks pervading the belly and the inside of the limbs, 'there being no white part', a character in which *antiquorum* differs from all normally coloured leopards, known to me, whether Asiatic or African. In this respect *antiquorum* is unique, as I pointed out some years ago (*Field*, December 14, 1907). Nevertheless Fitzinger, following Sykes, and Matschie following Fitzinger, adopted the name *antiquorum* for the Indian panther. Clearly it is inapplicable and the name must stand aside for the time being, attached to an unidentified race of panther.

The last name in the list to be considered is *pardus* employed by Lydekker on the assumption that Linnæus designated the Indian animal by that title. But, for reasons explained above, I adopt Thomas's restriction of the name *pardus* as a subspecific title to the Egyptian race.

The following is a list of the skins in the British Museum :—

Kashmir.—Three skins collected near the western boundary between the Indus and the Jhelum, north of Srinagar, and purchased from Mrs. Pauline Entwisle :—

(1) Tanned skin of an adult male from Ashkote. Coat smooth and soft, the hair on the back barely 1 in. long but a little longer than in South Indian panthers. Colour bright tawny yellow, with most of the rosettes of average size, not closely packed, about ½ in. apart, some tolerably large about 1¾ by 1½ in., inclosing a small

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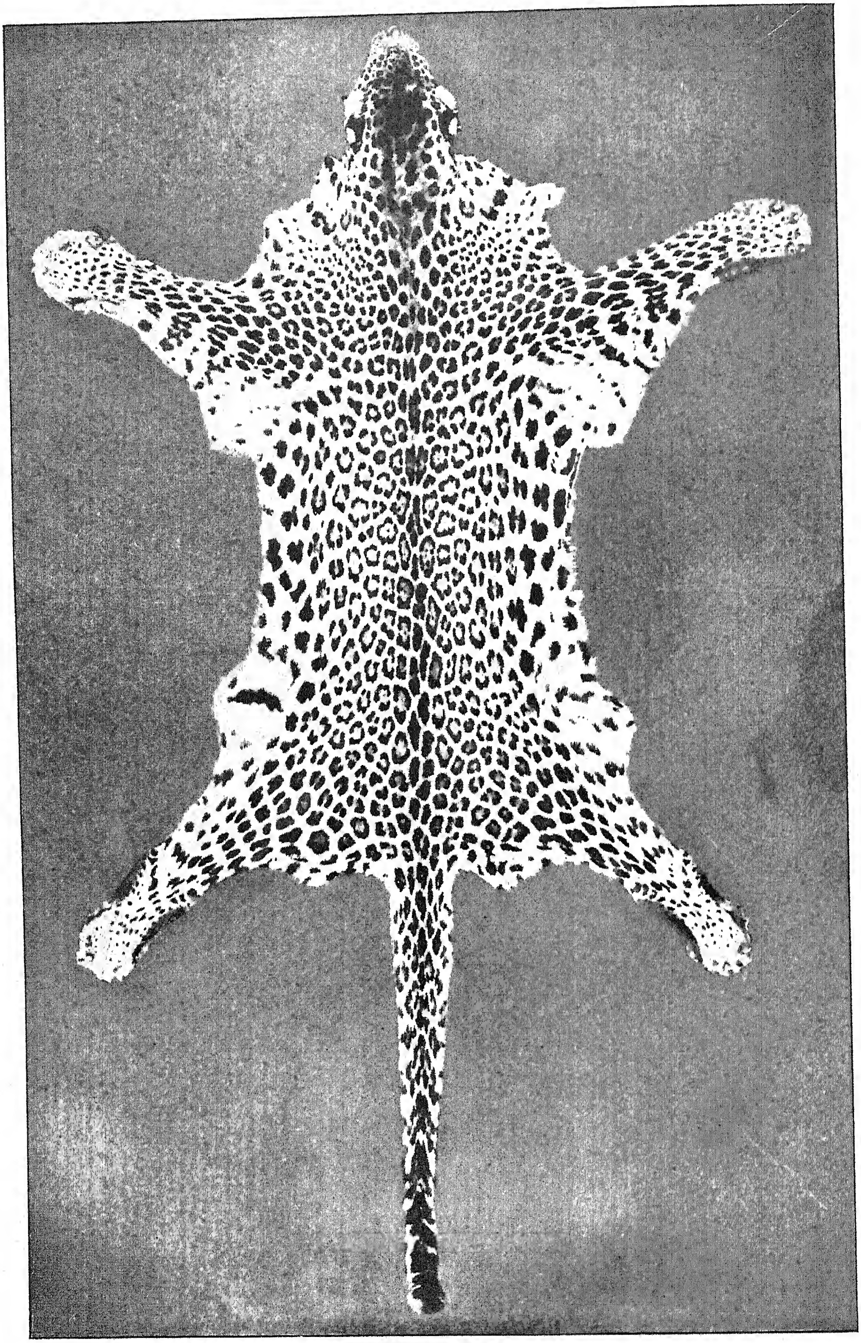
[1] Hence Allen's statements that the type of *antiquorum* was in the Paris Museum and that Griffith was the author of the name are alike erroneous (*Bull. Amer. Mus. Nat. Hist.*, 47, pp. 250-251, 1924).



Indian Panther (*P. pardus fusca*).
Skin from Rikhikesh.

black spot, some with thin rims, as in the Persian and Asia Minor panthers, all with darker centres. Head and body 5 ft. 5 in., tail 3 ft. 2 in., total 8 ft. 7 in.

(2) Tanned skin of old female from Nasair, a little darker than the last and with slightly smaller spots, but very like it and not differing appreciably either in colour or pattern from the skin from Hausbavi in Dharwar mentioned below. Head and body 4 ft. 6 in., tail 3 ft. 1 in., total 7 ft. 7 in.

(3) Untanned flat skin of adult female from Kannah, closely resembling the last two. Head and body 4 ft. 5 in., tail 2 ft. 9½ in., total 7 ft. 2½ in.

Nepal.—According to Hodgson's unpublished sketches, the panthers of Nepal are very variable in colour and pattern, which is not surprising considering the diversified physical features of the country. His notes suggest environmental variation; but the data are at present insufficient to justify definite conclusions on the point. There are five skins in the British Museum collected by Hodgson, merely ticketed Nepal. Three of them are black, with the M.S. name *pernigra* attached. The others, two females, have noticeably harsh and longish fur, about 1 to 1¼ in. long on the back, suggesting a high altitude habitat. One is tolerably normally coloured, but the ground tint is darkish, almost rusty buff; the rosettes are moderately large with darker centres; the belly is not so white as usual, being tinged with buff, and the throat is very distinctly washed with rusty buff.

The other skin differs somewhat and must have come from a very handsome animal. The dorsal area, 3 or 4 inches wide, is ochreous buff; but the shoulders, flanks and sides are remarkably pale, dirty whitish, strongly emphasising the rosettes which have rusty centres and are tolerably large, some up to 2 by 1½ in. in diameter.

Another female skin, ticketed Nepal (R. Everest) is very like the last. These Nepal skins are too wrinkled to give dimensions of any value.

Bhutan Duars, Bharnabavi, 600 ft. (N. A. Baptista for the Mammal Survey). A young female, less than 4½ ft. long and in poor condition, is very like the pale coloured skins from Nepal but has smaller rosettes.

Rikhikesh, near the Ganges, 3,000 ft. at the foot of the Himalayas, probably near the Siwalik Hills (Capt. F. S. Tuker). A splendid skin, dressed as a rug, of a male killed in February. The coat is rather harsh and thick, but short, the hair on the back being only about ½ an in. long. The colour is remarkably pale, the flanks being whitish buff which blends with the pure white of the belly and with the tawny buff hue of the back. The rosettes are unusually large, the largest being 2½ × 2 in. or 3 × 1½ in.; they are mostly complete, well spaced, and stand out boldly on the pale ground colour by reason of their darker centres.

This skin, the handsomest and most boldly marked Indian skin in the National Collection, is shown on Pl. VII. The rosettes are as large as in typical Chinese panthers. The unusual paleness of the ground colour may be due to fading; but if so, the action of the light has not apparently affected the centres of the rosettes. The

head and body measure 6 ft., the tail 3 ft. 2 in., the total, no doubt the result of stretching, being 9 ft. 2 in. Nevertheless, the jaws, which were left in the skin, exceed a little in length those of the largest Indian panther skull entered on my list. Probably the skull exceeded 10 in. in total length.

Dehra Dun, Barkot, 5,000 ft., December 1915 (Capt. F. S. Tuker). The tanned skin of a young animal recalling the specimen from Rikhikesh in its generally pallid coloration and probably also faded; but differing in being longer and thicker coated, the hair on the back being about 1 in. long, and in having the spots more closely set and much smaller, the largest about $1\frac{1}{2}$ by 1 in.

Oudh, Haripur Kheri (A. P. Millard). A handsome skin with a bold pattern recalling the one from Rikhikesh but with smaller rosettes and darker in tint and the fur less harsh and close, the hair measuring on the back about $\frac{3}{4}$ in. The largest rosettes, about $\frac{1}{2}$ in. apart, are about $1\frac{1}{2} \times 1\frac{3}{4}$ in. and some of them enclose a central spot. In colour and pattern this skin is almost intermediate between the skins from Rikhikesh and Ashkote in Kashmir described above. It also serves in a measure to link the Rikhikesh specimen with those from Bengal described below, although much handsomer than the skin from Daltonganj. The animal was a male, measuring in the flesh just over 7 ft., but no skull is available to show whether it was fully adult or not.

Bengal, Daltonganj. Adult female shot in March by C. A. Crump for the Mammal Survey. An undressed, short-coated skin, the hair on the back about $\frac{3}{4}$ of an in. and on the belly about $1\frac{1}{4}$ in. long; the colour a little darker and more ochreous than in the Kashmir skins, the flanks being scarcely noticeably paler than the back; the rosettes considerably smaller and more closely set, the largest about 1×1 in., their centres hardly noticeably darker than the ground colour except near the belly. Measurements in the flesh: head and body 3 ft. $5\frac{1}{2}$ in., tail 2 ft. $7\frac{3}{8}$ in., making the total approximately 6 ft. 2 in.

Bengal, Hazaribagh (R. E. S. Thomas). A semi-albino skin, with tan coloured spots and made up as a rug. In shortness of coat and size and spacing of spots closely resembling the skin from Daltonganj.

These two skins from Hazaribagh and Daltonganj respectively are of particular interest because they are the only ones in the National Collection which are topotypical in the sense that they came from the Bengal district whence the type-specimen of this race of panther, named *fusca*, was exported.[1] Hence it may be inferred that typical representatives of the Indian panther are marked with many small close-set spots on a reddish-tawny ground colour.

A photograph, kindly sent to Mr. Millard by Mrs. Ralston, of

[1] Those who have the opportunity of consulting De la Métherie's original figure of *fusca* will notice that the spots are comparatively few in number, large and well-spaced. But this figure was copied from the figure of another panther illustrated by Buffon, the only modification being the darkening of the ground colour to indicate the melanism. So far, therefore, as the pattern is concerned, De la Métherie's illustration is valueless.

the skin of a panther shot by Col. Ralston at Sironcha in S. Chanda, on the Godavari, shows a very handsome pattern of rosettes, as large apparently as in the Rikhikesh example described above.

Mandri on the Tapti river about 24 miles E. of Surat in the Konkan. The tanned skin of a young male shot and kindly lent to me by Mr. T. B. Fry. The coat is smooth, not thick, the hairs on the back measuring about 1 in. long. In the general colour and in the size and spacing of the spots it is very like the example from Daltonganj, but the tint is slightly paler and a few of the rosettes are larger, the largest measuring $1\frac{1}{2} \times 1\frac{1}{2}$ in., although most of them are considerably smaller. This panther, which was shot in a coppice, measured in the flesh 6 ft. As dressed it measures: head and body 3 ft. 7 in., tail 2 ft. 8 in., total 6 ft. 3 in. Mr. Fry tells me that he shot other panthers in the Konkan and one about 16 miles from Nasik on the Deccan plateau, which, so far as he recollects, were similar to the one above described.

S. Dharwar, near Byadgi Station, 2,000 ft. alt., east of Hausbavi, (G. C. Shortridge for the Mammal Survey). The flat skin of an adult male resembling the skin from Daltonganj in general tint but a little paler and with the rosettes, of which the largest are about $1\frac{1}{2}$ by $1\frac{1}{2}$ in., larger and more spaced. It is interesting to note that there is no appreciable difference either in colour or pattern between this skin and the one recorded above from Nasair in Kashmir. The animal was shot on February 29, 1912, in dry open country, with rocky hills; and its measurements in the flesh were: head and body 4 ft. 2 in., tail 3 ft., total 7 ft. 2 in.—not a large panther as is also indicated by the skull.

A photograph, kindly supplied by Mrs. Ralston, of a panther shot by her son Col. Ralston at Hubli has small, close-set spots.

E. Mysore, Kolar Town, 4,026 ft. alt. The flat undressed skin of a male (G. C. Shortridge, for the Mammal Survey). Colour a little paler than in the Daltonganj skin but the pattern consists of small close-set spots and the coat is short and smooth, the hair on the back being about $\frac{1}{2}$ an inch long. The head and body measure 5 ft. $7\frac{1}{2}$ in., and the tail 2 ft. 7 in., making a total of 8 ft. $2\frac{1}{2}$ in.; but, judging from its narrowness and the elongation of the spots, the skin is a good deal stretched.

S. Coorg, Wottekolle, 2,000 ft. alt., January 13, 1912, (G. C. Shortridge, for the Mammal Survey). The flat, very handsome skin of a young male, darker and richer in tint than the other Indian skins, the ground colour being rusty fulvous. The rosettes also are unusually large and somewhat irregular in shape, the largest being about $1\frac{3}{4}$ by $1\frac{3}{4}$ in. The coat, although not long, measuring on the back only a little over $\frac{3}{4}$ of an in., is thicker than in the other skins from S. India.

Coimbatore.—Two skins, presented by Mrs. G. Cosens and made up into rugs. They are apparently much faded since they lack the bright tint of ordinary Indian panthers, being pale, greyish buff on the flanks and a little darker on the back. The coat is short and smooth, the hair on the back measuring about $\frac{3}{4}$ in., and the pattern consists of close-set rosettes, with darker tinted centres, only a little larger than in the Daltonganj skin. In the flesh, according to

the labels, they measured respectively 6 ft. 5 in. and 6 ft. 7 in. Judging from the teeth and jaws, all that was preserved of the skulls, these specimens were females, although the smaller of the two is labelled male.

Ceylon.—Three skins obtained by E. W. Mayor for the Mammal Survey suggest the occurrence of two races in the island, a paler and a darker; but the material is too scanty to justify any definite conclusion.

(1) Kala Oya. The flat skin of a sub-adult male has a short smooth coat, the hair being less than ½ an in. on the back. The general colour is decidedly pale, the tawny tint of the back gradually fading on the flanks where it blends imperceptibly with the white of the belly. The rosettes are small, the largest about 1 by 1½ in., and close-set with darker centres. The head and body measure 4 ft. 4 in. and the tail 2 ft. 8 in., total 7 ft.

(2) Keligama, Hambantota, in the Southern Province. Not quite so short coated as the skin from Kala Oya, the hair on the back measuring about ½ an in. long; but although the rosettes are close-set and small, the largest measuring about 1 by 1 in., the general colour is much richer and darker. This is the skin of a young female and measures 6 ft. in total length. She was shot while asleep on a rock.

(3) Ambawela.—The skin of a young male, measuring 6 ft. 2 in., somewhat resembles in colour the one from Hambantota, but is still darker in tint and thicker in the coat, the hair on the back measuring about ¾ in. But as in the other Ceylonese skins the rosettes are all small and close-set, a character which, combined with the deep rusty fulvous tint, gives this panther a close resemblance to the Javan race recorded below. The general colour, it may be added, resembles that of the skin from South Coorg, but the spots are much smaller and more packed.

Summary of the variations of Indian Panthers.—From these descriptions of the characters of individual skins from various localities the following summary may be made:—

(1) The typical Indian panther from Bengal, to which the name *fusca* was given, a type represented by the skin from Daltonganj, has the coat short and smooth, with scarcely any underfur; the ground colour is golden tawny, darker on the back than on the flanks and limbs, the under side is clean white, and the rosettes are close-set, numerous, small and thick-rimmed, with darker centres but no contained spots. With scarcely any variations of note this type is traceable westwards to the Konkan, southwards into Madras and Ceylon and as far north as Kashmir, although in Kashmir the coat is a little fuller and the pattern bolder and more open.

(2) In some cases the ground tint is markedly paler as in the skins made up as rugs from Rikhikesh and Dehra Dun which may be faded, and those from Coimbatore which are almost certainly faded. Also some of the old pallid skins from Nepal may be faded. But this explanation cannot be extended to the pale skin from Kala Oya in Ceylon which was recently collected and has not been exposed to the light, so far as I am aware.

(3) Here and there specimens occur in which the ground colour is noticeably darker, that is to say, more rusty or rufous in tint as in the skins from Ambawela in Ceylon, from South Coorg and one from Nepal.

(4) Marked variation in the larger size, reduction in number and wider spacing of the rosettes is exemplified more particularly by the skins from Rikhikesh and South Coorg; but the boldness of the pattern in these two is the only particular in which they are somewhat alike, the Rikhikesh skin being unusually pale and the one from South Coorg unusually dark. In Nepal skins the pattern is also bolder than in Bengalese and Madras skins described.

(5) The coat varies considerably in length, texture and thickness, Nepalese skins differing greatly in these respects from skins of the typical Bengalese and Madras panthers.

Although it is, in my opinion, in the highest degree probable that some at all events of the variations above indicated are associated with differences of habitat, the available material, consisting mostly of single skins from scattered localities, does not supply data justifying conclusions on that point sufficiently definite for the nominal establishment of local races. What is required is several measured, sexed and dated skins of young and full grown panthers from approximately the same place, taken at different times of the year, so that we may ascertain the range of individual variation, if any, in the colour, pattern and nature of the coat. From the analogy supplied by the large, pale coloured panthers inhabiting the arid districts of Persia and the small richly coloured panthers inhabiting the moist districts of Java, it may be supposed that somewhat similar differences will be found to obtain in India and Ceylon. Sportsmen in India, in whose hands the settlement of this question rests, will probably agree with the opinion, based on what I have seen and read, that the most conspicuous variations in colour, pattern and coat in Indian panthers are matters of environment, of rainfall, temperature, forest, open country and the like. But until more information on these points is forthcoming, I propose to assign all the Indian and Ceylonese panthers above described to the same race.

It is, however, by no means certain that the descriptions above given cover the range of variation in colour and pattern of the panthers provisionally assigned to this race.

The list emphasises the deficiency of material for examination. There are a few skins from Kashmir, from the watershed of the upper Indus and Jhelum; a few from Dehra Dun, Nepal, Oudh and western Bengal in the watershed of the Ganges; a few from western and southern India, from the Konkan and Dharwar to Coimbatore; a few from Ceylon. But from a large area of India, that is to say, from the Punjab, Rajputana, the Central Provinces, the Nizam's Dominions and the greater part of the Bombay Presidency, not a single skin is available. Until specimens come to hand from these districts and additional specimens from those in which the skins described were procured, our knowledge of these animals cannot be claimed to approach completeness.

The following table contains the principal dimensions of some skulls from Kashmir, India and Ceylon :—

	Inches				Millimetres		
Locality and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
Kashmir, Ashkote, ♂, ad.	9·8	8·6	6·2	2·8 × 1·5	27	20	17
,, Ghadipore, ♂, younger...	9·2	8·4	6·0	2·6 × 1·4	28	20	16
Nepal, ♂, ad. ...	9·2	8·3	6·0	2·6 × 1·2	25 +	20	16
,, ♂, younger...	8·8	7·8	5·5	2·5 × 1·3	25	17·5	15
,, ♂, ,, ...	8·5	7·6	5·3	2·4 × 1·3	25	18	15
United Prov., Bahraich, ♂	9·3	8·4	6·0	2·9 × 1·5	27	20	16
,, ,, Bachkahi, ♂, young...	8·1	7·6	5·0	2·5 × 1 3	27	19 +	15
,, ,, ♂ ...	9·7	8·7	6·2 +	2·8 × 1·7	26	19	16
,, ,, ♂ ...	9·4	8·4	6 1	2·7 × 1·6	28	20	17
,, ,, Gorakhpur, ♂, ad....	9·3	8·3	6·0	2·8 × 1·4	24	17	15
Gharwhal, Mundiapani, ♂, ad....	8 9	8·1	5·8	2·7 × 1·5	25	18	15
Bengal, Bhagalpore, ♂ ...	9·9	8·7 +	6·1	2·6 × 1·5	25	20	16
,, Daltonganj, ♂, younger...	8·6	7·5	...	2·5 × 1·4	25	19	16
Central Prov., Mhow, ♂	10·0	8·7 +	7·1	...	25	..	13
Dharwar, Hausbavi, ♂, ad....	8·9	8 0	...	...	25	19	14
,, Potoli, ♂, ad....	7·8	7·1	5·0	2·3 × 1·3	25	18	15
Kanara, ♂, young ...	8·7	7·7	5·4	2·5 × 1·3	27	19	15
Coorg, Wottekolle, ♂, young ...	7·9	7·2	5·1	...	22	17	13
Ceylon, Pomparrapu, ♂, old ...	9·2	8 3	5·8	2·8 × 1 6	23	17	...
,, Kala Oya, ♂, young ...	8·8	8·1	5·8	2·7 × 1·5	23	18	13
,, Ambawela, ♂, younger ...	8·4	7·4	5·3	2·4 × 1·3	25	18	14

Locality and Sex	Total length (Inches)	Cond. basal length (Inches)	Zygom. width (Inches)	Nasals (Inches)	Upper carnal (Millimetres)	Lower carnal (Millimetres)	Upper canine (Millimetres)
Kashmir, Nasair, ♀, old.	8	7·1	5·1	2·2 × 1·3	21	15	12
,, , Kannah, ♀, ad.	7·8	7·1	5·1	2·3 × 1·3	24	17	11
Nepal, ♀, ad.	7·4	6·9	4·9	2·1 × 1·3	26	19	14
United Provinces, ♀, ad.	8·4	7·5	5·3	2·6 × 1·4	25	18	13
Bahraich, Sohetwa, ♀, ad. ...	7·6	7·1	4·8	2·3 × 1·1	24	17	13
Gorakhpur ♀, ad. ...	7·6	7·0	5·0–	2·4 × 1·2	23	17	12+
Bengal, Daltonganj, ♀, ad. ...	7·3–	6·7–	4·7	2·1 × 1·1	22	15	11

The history of these skulls is as follows :—

Kashmir (Mrs. Entwisle); Nepal (♂ B. H. Hodgson, ♀ R. Everest); United Provinces, without special locality, (St. George Burke); United Provinces, Bahraich, Bachkahi and Gharwhal (B. B. Osmaston); Gorakpur (A. E. Osmaston); Bengal, Bhagalpore and Daltonganj (C. A. Crump for the Mammal Survey); Mhow, Central Provinces (specimen formerly in the Zoological Gardens); Dharwar, Kanara and Coorg (G. C. Shortridge for the Mammal Survey); Ceylon (E. B. Mayor for the Mammal Survey).

From the table it will be seen that adult and old male and female skulls range respectively on the average from 8 to 9 and from 7 to 8 inches in total length. A marked exception to this is supplied by the male skull from Potoli in Dharwar which, although fully adult, is not only smaller than some of the female skulls but has the shape of the skull of a female. The canine tooth is a little larger, it is true. Nevertheless I should have regarded the skull as that of a female, were it not that Mr. Shortridge is too trustworthy a collector to be likely to have fallen into error in the sexing of a specimen. The measurements of the skull from Mhow were recorded by me some years ago (*Proc. Zool. Soc.,* 1909, p. 208, fig. 23). The remarkable narrowness of the canine tooth is probably attributable to rearing in captivity; but the skull is no longer available for examination and verification of structural details.

The teeth of male panthers are on the average a little bigger than of females. In some instances the teeth are reduced in size by wear accompanying old age; but there are some puzzling variations which do not seem attributable to that cause. The male skull from Gorakhpur, for instance, has exceptionally small teeth for that sex.

In addition to those above enumerated the British Museum contains a number of skulls of much younger leopards, whose measurements it would be superfluous to record.

In Rowland Ward's *Records*, 1914, p. 500, there are measurements of three male skulls from Bijnor, Kathiawar and Belgaum measuring approximately in total length and width $10\frac{1}{4} \times 6\frac{1}{2}$, $10\frac{1}{4} \times 6\frac{1}{4}$ and $10 \times 6\frac{1}{2}$ in. respectively. To these in the 1928 ed., p. 485[1] are added three more from the Central Provinces, Gwalior and Bijnor measuring approximately $9\frac{3}{4} \times 6\frac{1}{4}$, $9\frac{1}{2} \times 6\frac{1}{3}$ and $9\frac{1}{4} \times 5\frac{3}{4}$ in. These dimensions send up the average derivable from my table and show that the skulls of male Indian panthers may surpass 10 in. in total length. But a skull in the *Records* which considerably surpasses the others in dimensions measures over 11×7 in. in length and width. This exceptionally long and narrow skull is the property of the Maharajah of Bhanagar and is entered merely as 'India', and no skin is mentioned in connection with it. The length of this skull as compared with its width makes me think it was that of a young tigress.

Panthera pardus millardi subsp. nov.

(Pl. VIII)

Type locality.—Kashmir.

Differing from the typical Indian panther (*P. pardus fusca*) represented by the skins described under that heading by having the coat longer and more furry and inclined to part in tufts when the skins are folded, the hair on the back being about $1\frac{1}{2}$ in. long and on the belly about 3 in. or more in length; but more particularly distinguishable by the colour, which lacks the bright fulvous, yellowish or reddish-buff tint of the normal form, the ground colour being greyish-buff, almost olivaceous in tone, with the rosettes small, thick-rimmed and close-set and combining with the darkish tint of the ground colour to give a generally dusky hue to the animal. The largest rosettes measure about 1×1 in. in diameter and the spaces between them from $\frac{1}{4}$ to $\frac{1}{2}$ in. wide.

The type of this race of panther is the tanned skin and skull of an adult female from Kashmir, without special locality, and purchased from Mrs. Entwisle. The measurements of the skin are: head and body 4 ft. 4 in., tail 2 ft. 10 in., total 7 ft. 2 in. A second half grown specimen, with the same history, has the coat somewhat longer, more inclined to be tufted and the pattern in consequence more obscure.

It is interesting to note that in the small size and close setting of the rosettes the two known skins of this panther are much more like the Bengal panthers from Daltonganj and Bhagalpore than they are like the other Kashmir skins, from Nasair and Ashkote, which have larger, thinner-rimmed and more widely spaced rosettes.

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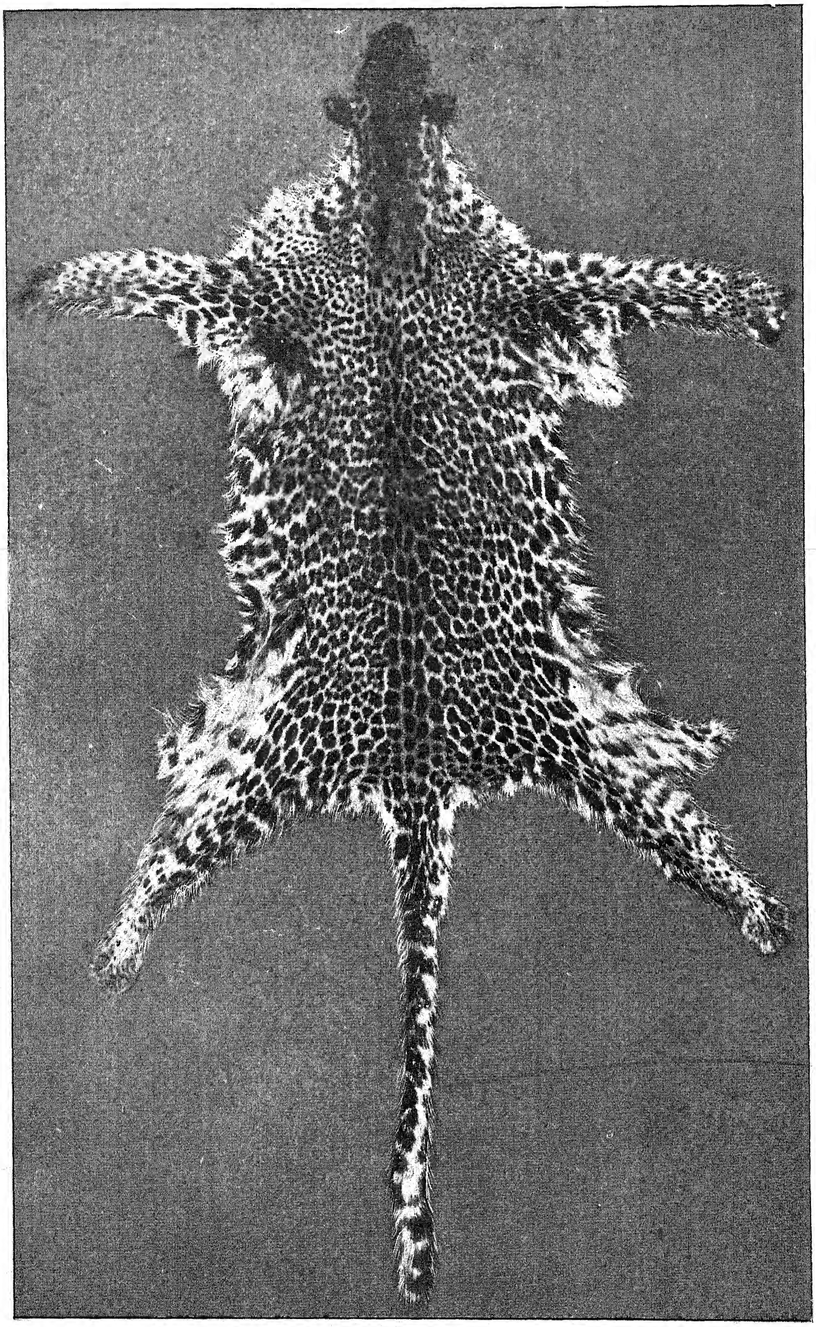
[1] In my paper on Tigers (*Journ. Bombay Nat. Hist. Soc.*, xxxiii, p. 518, 1929) I pointed out that there is an error in the dimensions of the panther skulls in the 1928 ed. of the *Records*, the lengths being entered as 'basal' instead of 'total', making the basal length about 1 in. too long. The only exception to this is the skull from Waterfall Shola, S. India (J. Limouzin) which stands fourth on the list. Here the basal length is correctly indicated; but the skull, which Messrs. Rowland Ward had not seen, was, in my opinion, wrongly identified in India and was that of a tiger, not a panther.



Millard's Panther (*P. pardus millardi*).
Skin from Kashmir.

The differences between these two Kashmir types recall the differences between the West African forest leopard and East African leopards which frequent more open country. Unfortunately we have no particulars regarding the physical features of the districts from which the Kashmir skins respectively came; but the inference is that the habitats of the two kinds are very different.

Although resembling some of the panthers from Persia in the absence of the bright yellowish hue, this new form is much darker and cannot be confused with them.

The measurements of the skull of the type are as follows :—

	Inches			Millimetres			
Locality & Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
Kashmir ♀, ad...	8·2 +	7·4	5·4	2·3 × 1·4	24	17	12

The dimensions of this skull, as well as of the skin, show that this panther is as large as the typical Indian form; but I can find no distinguishing differences between the two in their cranial characters.

I dedicate this panther to my friend Mr. W .S. Millard, late Hon. Secretary of the Bombay Natural History Society, as a small token of the great work he has done in furthering the interests of zoology and natural history in India, more particularly in being the pioneer in the organization of the Mammal Survey which has yielded such magnificent results in adding to our knowledge of the mammalian fauna of the country.

The Panthers of Manchuria and China

The available skins from Manchuria and China show that our knowledge of the panthers of these countries is as defective as our knowledge of the panthers of India and that far more material is required before it will be possible to reach any satisfactory conclusions regarding the names and distribution of the different kinds of which two, sometimes three, may be found quoted in literature, under the names *fontanierii* and *villosa,* to which *orientalis* is sometimes added. The difficulties with which the question is beset will appear in the sequel; but provisionally I assign the skins to three races.

Panthera pardus orientalis, Schlegel

(Pl. IX)

Felis orientalis, Schlegel, *Handleidung der Dierkunde* I, p. 23, Pl. II, fig. 13, 1857; Martens, *Zool. Gart. B. V.,* 7, p. 230, 1864.

Panthera orientalis, Fitzinger, *SB. Akad. Wiss. Wien,* 1868, p. 399.

Leopardus pardus orientalis, Satunin, *Conspect. Mamm. Imp. Ross.,* p. 160, 1914.

Felis villosa, Bonhote, *Ann. Mag. Nat. Hist.,* xi, p. 475, 1903,

Felis pardus villosa, Lydekker in Rowland Ward's *Records,* 1914, p. 498; also 1928, p. 482.

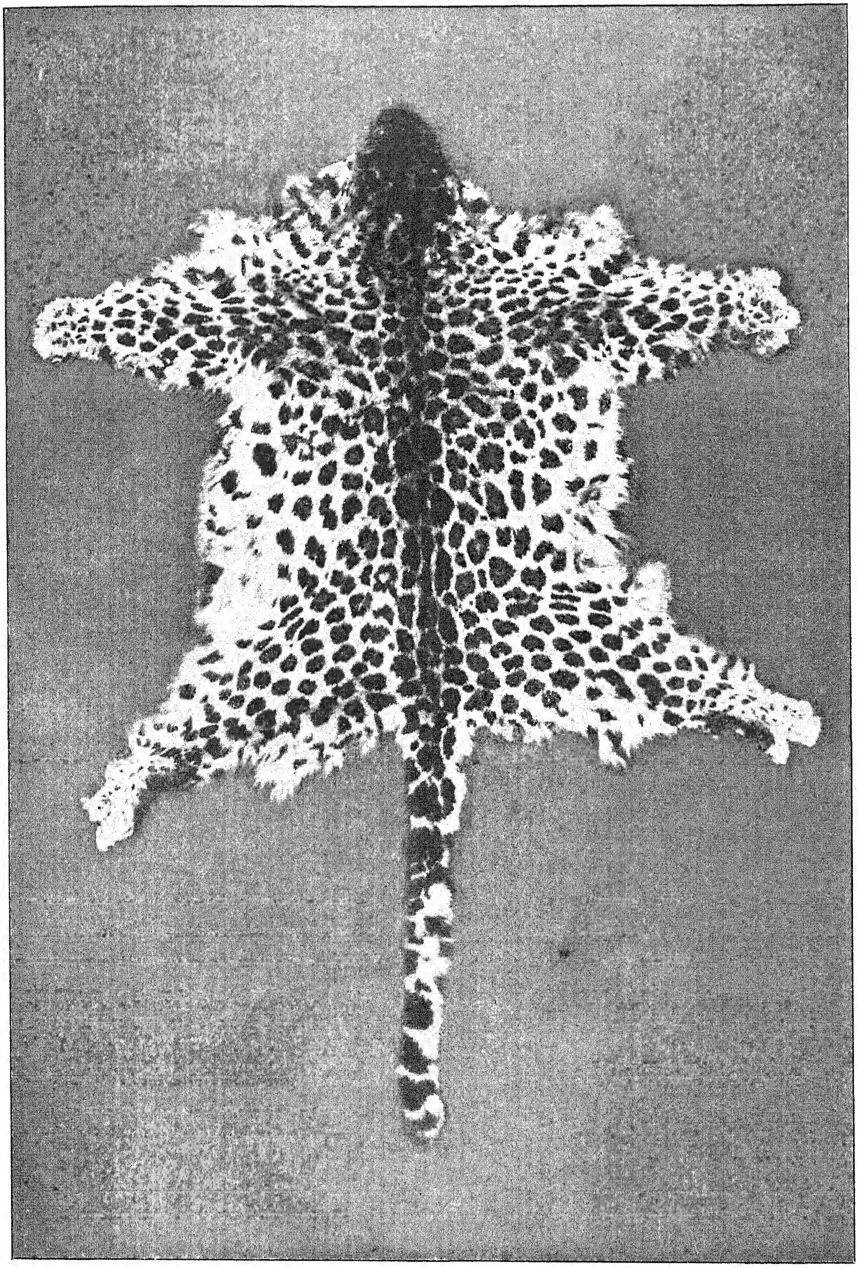
Type Locality.—Korea (*orientalis*); Amur Bay (*villosa*).

Distribution.—Manchuria and N. China (according to Sowerby).

Notes on synonymy.—Schlegal gave the name *orientalis* to a Korean panther which he briefly described as differing from the ordinary form in having much longer hair and much larger spots; and his figure represents an animal with a bushy tail and very large well-spaced spots composed of irregularly shaped rings, broken up in places, on the body, and of solid black spots on the belly and limbs. He did not refer to the tint. Fitzinger, however, amplified Schlegel's account by describing this panther as like *Panthera irbis* [*Uncia uncia,* the ounce or snow-leopard] but with the hair not so long and the colour whitish yellow, the spots on the sides being large, distinctly defined, black ocelli arranged in longitudinal series, those on the limbs being solid and angular. This description agrees very closely with the skin of the typical specimen of the panther from Amur Bay, near Vladivostock, to the north of Korea, described as *Felis villosa* by Bonhote who was apparently unacquainted with Schlegel's and Fitzinger's descriptions of *orientalis.* Bonhote contrasted *villosa* with the more richly tinted and more southern, Chinese panther which Milne Edwards had named *Felis fontanierii.* But he stated he would have hesitated to describe *villosa* as a distinct species on the evidence of the skin alone, the skull being in the mounted specimen and unavailable for examination. He gave, however, two corroborative reasons for his decision, both of which were wrong. He assumed that the leopard from Amur Bay was identical with one from the west of Pekin, the skull of which had been described by Gray in 1867 as representing a new species, *Leopardus chinensis;* and since this skull differs somewhat in shape from those of some leopards from Kiukiang in the British Museum, which Bonhote assigned to *fontanierii,* he thought he had secured cranial as well as colour characters whereon to establish *villosa.* Under the circumstances he should have given the name *chinensis* to his Amur Bay specimen; but according to him that name was invalid when published in 1867, being preoccupied in the genus *Felis* for the smaller Chinese cat *Felis chinensis* dating from 1837, as I have explained above. But Bonhote was also quite wrong in his supposition that the skin from Amur Bay and the skull of *chinensis* belong to the same type of leopard. The forest to the west of Pekin was alike the home of the types of *chinensis* and of *fontanierii,* as stated below. These two names are therefore synonyms: and we know from M. Edward's figure that the leopard of that area is dark and richly coloured, not creamy buff like *villosa.*

There are in the British Museum only two skins which I assign to this race.

(1) The flat dressed skin of an old ♂ from Amur Bay, the type of *Felis villosa,* presented by Lord Rothschild in 1895. The coat is full and soft and the tail very bushy; the hair on the back measures about 1¼ in., on the belly 2 in. and in the middle of the upper side of the tail 1¾ in. The ground colour is creamy buff, very noticeably paler than in the Chinese race *japonensis* which



Amurland Panther (*P. pardus orientalis*).
Skin from Amur Bay. Type of *F. villosa*.

occurs farther south. The rosettes are large, few in number and well spaced, mostly with dark dusky centres showing up very strongly against the pale hue of the interspaces. The largest on the flanks measure about 2 × 2 in., and the interspaces up to about 1 in. on the flanks. The skin measures: head and body 47 in., tail 30½ in., total 6 ft. 5½ in.; but the skin is obviously stretched from side to side, thus shortening its length.

(2) A mounted specimen, presented by Rowland Ward, of which the exact locality is unknown. On the stand it is labelled 'Korean Leopard, Northern China', but in the Register it is entered as coming from Manchuria. Although not so pale as the type of *villosa,* it is not so red as the Pekinese and Central Chinese panther (*japonensis*), and the centres of the rosettes are duskier. The largest on the flanks measure about 2 × 2 in. in diameter and the interspaces about ½ in. The coat also is not so luxuriant as in the type of *villosa,* measuring on the back about ¾ in. and on the belly 1¾ in. The skin, as mounted, measures: head and body 49 in., tail 30½ in., total 6 ft. 7½ in. This panther seems to be almost intermediate between *orientalis* (*villosa*) and *japonensis* (*fontanierii*), which follows.

The only skull I have for examination is that of the type of *villosa,* which was extracted from the mounted specimen after Bonhote described the latter. Its available dimensions are as follows:—

	Inches			Millimetres			
Locality and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Canine
Amur Bay ♂, old	8·3	7·6	...	2·7 × 1·4	...	...	15

This skull, that of an old male, is defective in some particulars. It is decidedly smaller than the skulls of male Indian, Persian and Asia Minor panthers, exceeding indeed only by a small fraction of an inch female skulls of those races. But I can distinguish in it no peculiar structural features.

Sowerby (*Journ. Asiat. Soc. N. China,* 47, p. 62, 1916) describes this race as the Manchurian and Amurland leopard and states that it occurs in the states of Chihli (Pichili), Shensi, N. Shensi and Kansu in north-western China; but since the typical locality of the leopards described as *fontanierii* was to the west of Pekin, it seems probable that he confused the two races. His account, however, is very puzzling because he also records *fontanierii* from S. Shensi and Schechuan as if he were acquainted with the two races and distinguished them. Moreover, in *Fur and Feather in North China,* p. 46, Pl. XI, 1914, he published a photograph of a stuffed specimen of a panther under the name *villosa* which seems to be correctly identified; and last year (*China Journ.* 8, p. 346, 1928) he again discussed these two leopards *villosa* and *fontanierii,* calling the former the Amur leopard and publishing a photograph of a specimen,

certainly correctly identified since it came from Gamoff near Vladivostock close to the place whence the type of *villosa* was procured. It is likely enough that *villosa* or, as I have called it, *orientalis*, occurs in N. China, but I do not know the evidence upon which the statement rests. Nevertheless I quite agree with Sowerby's view that the existence of this pale coloured, large spotted, thick coated leopard in that part of Asia accounts for van Schrenk's statement that the snow-leopard or ounce (*Uncia uncia*) occurs in Amurland; and in this connection it may be recalled that Temminck (*Fauna Japonica*, p. 5, 1842) stated that skins of tigers and ounces were imported to Japan from Korea. Probably the skins he identified as those of the ounce were the skins of *P. pardus orientalis.*

Panthera pardus japonensis, Gray

Leopardus japonensis, Gray, *Proc. Zool. Soc.*, 1862, p. 262, Pl. 33.

Leopardus chinensis, Gray, *Proc. Zool. Soc.*, 1867, p. 264, text fig. of skull.

Felis fontanierii, A. M. Edwards, *Ann. Sci. Nat. Paris* (5), viii, p. 375, 1867; *id. Rech. Mamm.* p. 208, Pls. 29-31, 1872.

Felis (Leopardus) grayi, Trouessart, *Cat. Mamm. Suppl.*, p. 268, 1904.

Alleged locality of type.—Japan. Type not known.

Distribution.—North and Central China, precise range unknown.

Notes on synonymy.—The name *Leopardus japonensis* was given by Gray to a furrier's skin of a leopard stated to have been exported from Japan. As regards the skin itself, this statement may have been true. But there are no indigenous leopards in Japan; and if the skin came from that country it was no doubt traded there from the mainland of China or Korea. Fortunately Gray published a coloured plate drawn from this skin; and this agrees so closely with the coloured plate of the leopard from the environs of Pekin named *Felis fontanierii* by Milne Edwards that there is no reasonable doubt of the racial identity of the two. The likeness was detected by Anderson; but he rejected the name *japonensis* on account of the uncertainty of the precise locality of the furrier's skin. Milne Edwards himself was very doubtful of the distinctness of the two and could only mention one or two unimportant differences in pattern, such as may fall well within the range of individual variation. But in no case can *fontanierii* be retained for the Pekinese leopard because it is antedated by *chinensis* given by Gray to the skull of a leopard from the mountain forests to the west of Pekin, the locality of the example of *fontanierii* figured by Milne Edwards. The names were published in the same year; but Milne Edwards' reference to *chinensis* in his original description of *fontanierii* shows that *chinensis* was published first.

The name *grayi* was proposed as a substitute for *chinensis* by Trouessart on the grounds that *chinensis* was preoccupied for *Felis chinensis* given to a totally distinct species of the *Felidæ* by Gray himself in 1837. But Gray was sufficiently intelligent to see that the leopard to which he gave the name *chinensis* was generically distinct

from the cat and his name for the leopard would stand if not antedated by *japonensis*.

The coloured illustrations of *japonensis* and *fontanierii* published respectively by Gray and Milne Edwards show that this Chinese race resembles *orientalis* in having a thick coat and a bushy tail, at least in winter, and also in the size and wide spacing of the rosettes, but differs in being of a rich, dark-reddish hue with the centres of the rosettes still redder but not fuscous as in *orientalis*.

Milne Edwards figured two specimens, a nearly full sized male and a younger specimen, which show variation in the pattern worth noticing. The older example is reddish on the back, paler on the sides, and the rosettes have rusty centres, the interspaces being free of small spots. The younger has comparatively few very widely spaced large rosettes, the interspaces being occupied by many small irregularly shaped solid spots. Both these examples came from the environs of Pekin.

The British Museum, unfortunately, has no skins from the latitude of Pekin which quite resemble *japonensis;* but there are three skins collected by F. W. Styan at Kiukiang to the south of the Yang-tse-king in Central China, which were assigned to *fontanierii* by Bonhote and others, and apparently correctly. At all events I can find no characters by which they can be distinguished. The following notes on them may be useful.

(1) A flat, undressed winter skin of an almost adult male measuring: head and body 50 in., tail $32\frac{1}{2}$ in., total 6 ft. $10\frac{1}{2}$ in. The coat is tolerably thick and full, the hair on the back being $1\frac{1}{5}$ in. long, on the belly $1\frac{3}{4}$ in. and on the neck where it rises into a median crest or mane $1\frac{3}{4}$ in., and on the tail which is thick and bushy nearly 1 in. The colour is rich, rusty fulvous on the back, becoming gradually paler on the flanks where it blends with the white of the belly. The centres of the rosettes which are large, are rusty, practically the same colour as the intervening spaces on the back, but much redder than the intervening spaces on the flanks and therefore more conspicuous. Low down on the flanks the centres become infuscate. The large rosettes are nearly 2×2 in. and the intervening spaces about $\frac{3}{4}$ in.

(2) A younger male specimen, also undressed and ticketed December, is very like the last, but the hair on the body and tail is a little fuller and there is no crest on the neck. It measures: head and body 46 in., tail $31\frac{1}{2}$ in., total 6 ft. $5\frac{1}{2}$ in.

(3) The undressed skin of a practically adult male ticketed Lushan Hills, Kiukiang, November 8th. It resembles the others but the coat is not so luxuriant and the colour not quite so rich, neither the back nor the centres of the rosettes being quite so rusty.

The first and second of these skins in their rich coloration and the size of their rosettes seem to resemble closely the specimen described by Milne Edwards as *fontanierii,* although Kiukiang is a long way to the south of Pekin. The third in its somewhat paler coloration approaches the next described race.

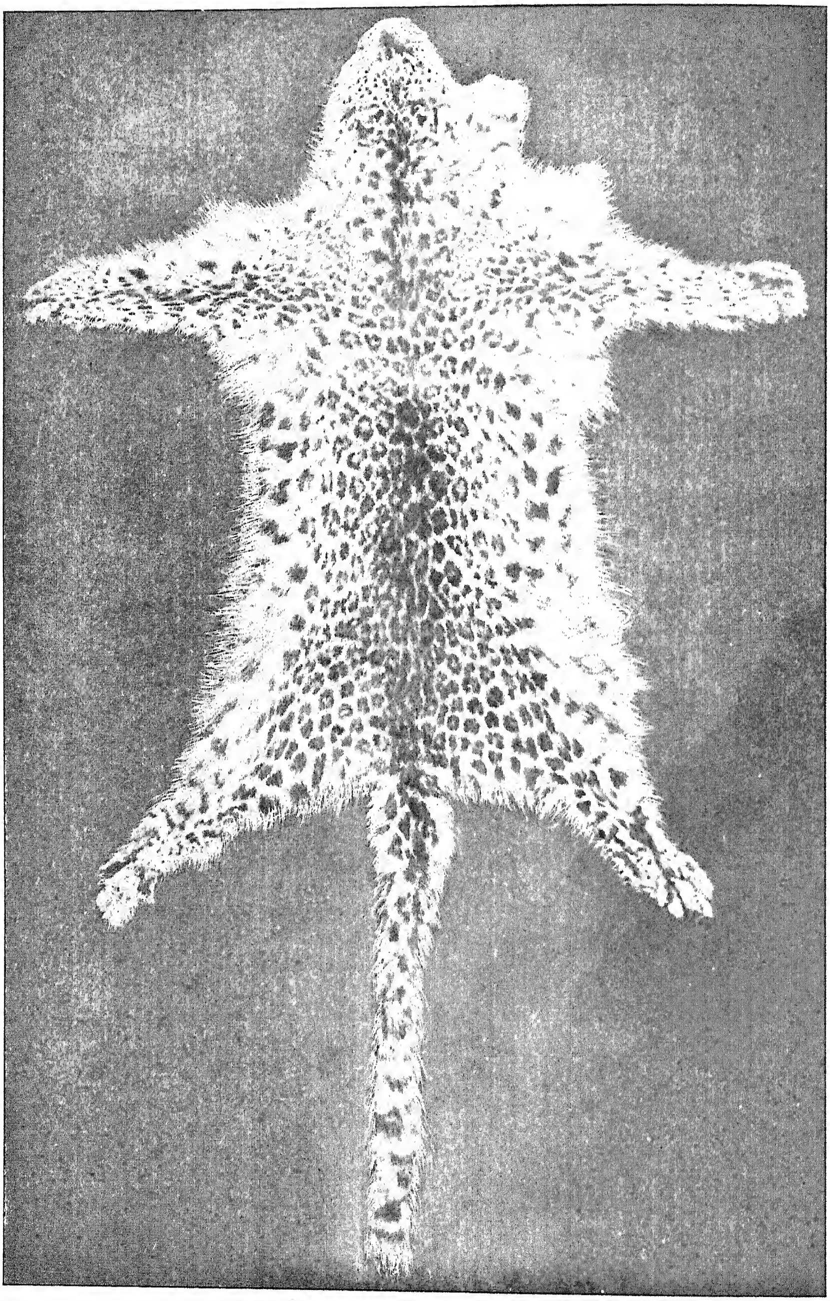
Under this heading mention must finally be made of an exceedingly handsome, flat, tanned skin from Kwantung in South China, obtained by Swinhoe and briefly referred to by him when

comparing the leopards of Northern and Southern China (*Proc. Zool. Soc.*, 1870, p. 4). He described it as very richly coloured but otherwise like the leopard of India. This is not strictly true, the pattern being much bolder than in any Indian skin I have seen. The colour is very like that of the first described skin from Kiukiang, but the rosettes are larger and thicker rimmed and their centres instead of being rusty fulvous are inclined to be dusky. The largest measure about $2\frac{1}{2} \times 2$ in. in diameter. In size and spacing they recall the rosettes of *orientalis*. But both in colour and pattern the skin is so like the type of *japonensis* as figured by Grey that Dr. Schwarz regardless of its history wrote on the back of the label 'type of *japonensis* Gray'. This it most certainly is not, because, apart from its different history, the coat is quite short and smooth, being less than 1 in. on the back and less than 2 in. on the belly, and the tail is in no sense bushy. The coat is shorter than in any of the Central Chinese skins described above, but its date is unknown and none of the others are summer skins. The skin measures: head and body 4 ft. 5 in., tail 3 ft. 2 in., total 7 ft. 7 in. Provisionally only can it be referred to *japonensis*. It may prove to belong to the Annam race described below.

The following are the measurements of the available skulls assigned to *japonensis* :—

Locality and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
W. of Pekin ♂, young ...	7·2	6·8	...	...	28	20	14
Kiukiang ♂, ad. ...	8·7	7·8	...	2·4 × 1·3	26	17	14
,, ♂, ad. ...	8·3	7·7	5·3	2·5 × 1·3	25	19	14
,, ♂, young ...	7·8	...	4·7	2·3 × 1·3	23	18	13
W. of Pekin ♀, ad. ...	7 +	6 5	4·6	2·2 × 1·1	24	17	11

The dimensions of the male skull, the first on the list, from the West of Pekin are taken from M. Edward's figure of the type of *fontanierii,* which he declared to be an adult animal. But the distinctness of the sutures, especially of the interparietal bone, the general shape and the short occipital crest show most emphatically that it was young. The only puzzling characteristic of the skull is the great size of the upper carnassial which is as large as the largest carnassial shown in my table of dimensions of Indian skulls. Possibly the artist exaggerated its size. The two male skulls from Kiukiang marked adult are probably not quite full sized. They are young adults, the basioccipital suture being still visible, and the same applies to the female skull, the type of *chinensis,* from the West of Pekin. But it will be seen that on the average the skulls, like that of the old male of *orientalis* (type of *villosa*), are smaller than the skulls of Indian panthers.



Duke of Bedford's Panther (*P. pardus bedfordi*).
Skin labelled "N. China" (Swinhoe).

Panthera pardus bedfordi, subsp. nov.

(Pl. X)

Felis japonensis, Swinhoe, *Proc. Zool. Soc.,* 1870, p. 628. (Not *japonensis,* Gray).
Felis fontanierii, Thomas, *Proc. Zool. Soc.,* 1911, p. 687. (Not *fontanierii,* M. Edwards).

Type Locality.—Shong Chou in S. E.. Shensi, 3,000 ft.
Distribution.—Shensi, Hupei, ? N. China.

Resembling *P. pardus japonensis* in its thick coat and bushy tail, but paler and much less richly coloured, the ground tint being tawny buff with no rusty hue on the back or in the centres of the rosettes which are merely a slightly darker shade than the interspaces; the rosettes also are somewhat smaller, more closely set and altogether less conspicuous than in *japonensis.*

The British Museum has the following skins which I assign to this race :—

(1) Shong Chou in S. E. Shensi. The made-up skin, the type, of an old female shot on November 8th by M. P. Anderson at an altitude of 3,000 ft. on the Duke of Bedford's collecting expedition to Central China. Its measurements in the flesh are: head and body $43\frac{1}{4}$ in., tail 31 in., total approximately 6 ft. 3 in. The colour and pattern are as described above. The length and thickness of the coat are approximately as in the skin assigned above to *japonensis* from the Lushan Hills, Kiukiang (Styan), the hair on the back being about 1 in. long and on the belly 2 in., and the largest rosettes about $1\frac{4}{5} \times 1\frac{2}{5}$ in. in diameter. The two animals were killed in the same month, November, when the winter coat would hardly have attained its full development.

(2) Paoli in Shensi. A very handsome, tanned skin, presented by Father Hugh, measuring: head and body 35 in., tail $34\frac{1}{2}$ in., total 7 ft. $3\frac{1}{2}$ in. This skin is probably that of a male in winter coat, the hair on the back measuring $1\frac{1}{2}$ in. and on the belly 2 in. The colour is almost as in the type, but the rosettes are slightly larger and more conspicuous, with rather darker centres.

(3) Tong Shang in Hupei. The made-up skin of a young male, ticketed January 18 (F. W. Styan). It measures: head and body 41 in., tail $25\frac{1}{2}$ in., total 5 ft. $6\frac{1}{2}$ in. The colour is as in the type but the pattern is less clearly defined, as is usual in young panthers. The hair is not reversed on the neck and there is no median crest. On the back it measures $1\frac{1}{2}$ in. and on the belly about 2 in.

(4) ? N. China. A flat, tanned skin, one of the two referred to by Swinhoe (*Proc. Zool. Soc.,* 1870, p. 4) and assigned by him to *japonensis,* Gray. It measures: head and body 50 in., tail 31 in., total 6 ft. 9 in. The colour and pattern are similar to those of the type, but the coat is fuller and softer, the hair being $1\frac{1}{2}$ in. on the back, $1\frac{3}{4}$ in. on the nuchal crest, $2\frac{1}{2}$ in. on the belly and $1\frac{1}{4}$ in. on the middle of the tail. A photograph of the skin, a trade skin picked up in Pekin by Swinhoe, is shown on Pl. X.

This panther is, I suspect, the race identified by Sowerby (*Journ.*

Asiat. Soc. N. China, 47, p. 62, 1916) as *fontanierii*, which he records from S. Shensi and Schechuan.

The differences in colour and pattern between this panther and the richly coloured form assigned above to *japonensis* are puzzling. No doubt they are due to a difference of environment and I suspect that the habitat of *bedfordi* is more or less open, mountainous country, and of *japonensis* comparatively low lying forest or jungle.

The only skull of this race I have seen is that of the type, an old female from Shong Chou in S.E. Shensi. Its measurements are as follows:—

	Inches				Millimetres		
Locality and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
S. E. Shensi, ♀, old ...	7·7	6·9	5·1 –	2·2 × 1·2	22 +	16	12

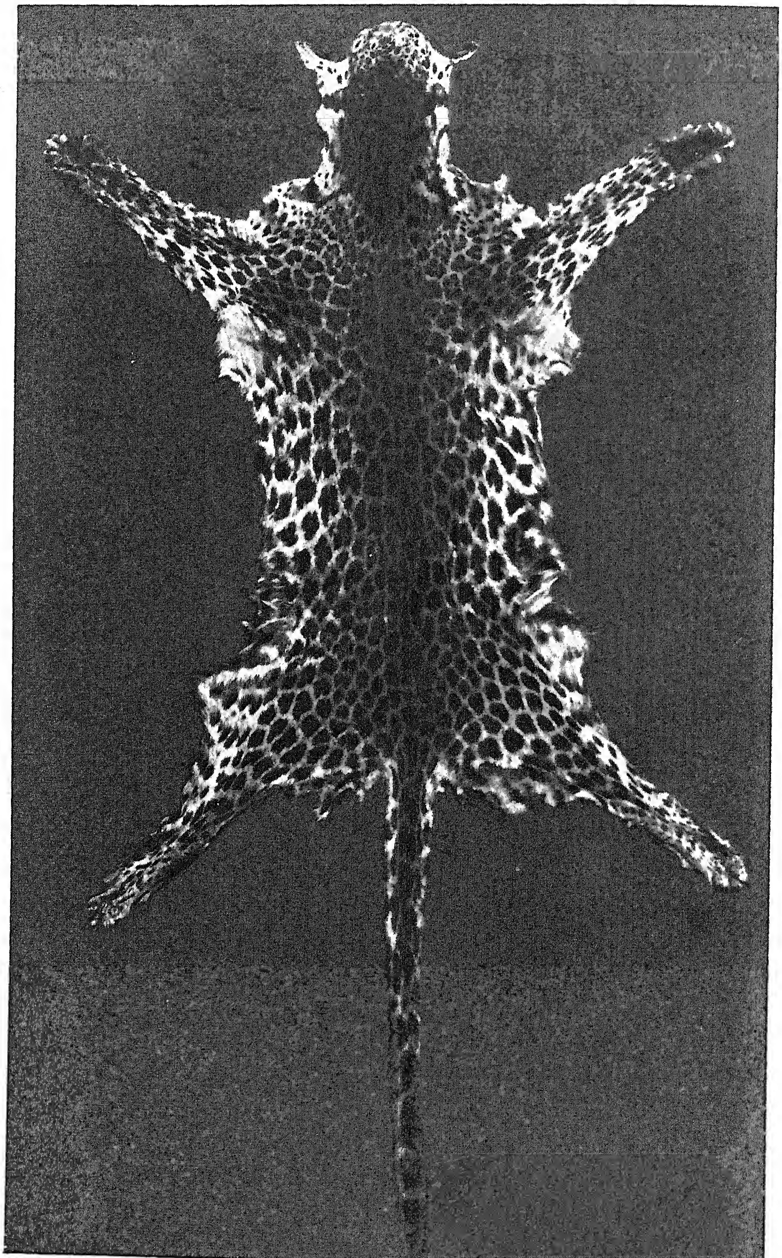
The skull is only slightly larger than that of the type of *chinensis* from the west of Pekin. It differs, however, very considerably in shape, being noticeably lower and flatter over the fronto-nasal area. But I attribute this difference to age, the Shensi skull belonging to a much older animal than the one from Pekin which was barely adult.

The Panthers of Burma, Annam and the Malay States

Of skins and skulls from these countries I have seen only a few. But according to Lydekker the leopard of Malaya, to which he gave the inadmissible name *variegata*, Wagner, is a large-spotted race. This description applies to the skin of an adult female obtained at Tonghoo in Burma by Mr. J. M. D. Mackenzie for the Mammal Survey. The coat is short, only just over ½ an inch long on the back, and the general colour is very much as in the Daltonganj skin, representing typical *fusca*, but is a little brighter and richer in tint and the pattern is handsomer because the rosettes, although not widely spaced, are larger, many of them being 1¾ × 1¾ in. in diameter. The animal measured in the flesh: head and body 3 ft. 8 in., tail 2·10½ in., total 6 ft. 6½ in. But the skin does not differ more from the typical form of *fusca* than does the skin from S. Coorg, for example; and provisionally I refer this Burmese example to that race.

Black leopards appear to be not uncommon in the Burmese area. One was obtained by G. C. Shortridge on Mt. Popa in Chindwin, and I have seen one from the Shan States in Mr. Poland's collection.

An example from Annam, represented by the skin and skull, seems sufficiently different from typical *fusca*, the Indian race, and from the named Chinese races, *japonensis* and *bedfordi*, to receive nominal distinction.



Delacour's Panther (*P. pardus delacouri*).
Skin from Hué, Annam.

Panthera pardus delacouri, subsp. nov.
(Pl. XI)

? *Felis pardus variegata,* Lydekker, in Rowland Ward's *Records,* 1914, p. 498, and 1928, p. 482; *id. Game Animals of India,* etc. (revised by Dollman), p. 316, 1924; not *variegata,* Wagner.
Panthera pardus, Thomas, *Proc. Zool. Soc.,* 1928, vol. ii, p. 834.

Type Locality.—Hué in Annam. Type in the British Museum.
Distribution.—Range unknown, very possibly S. China, Siam and parts of Malaya.
Note on the suggested synonymy.—As stated above, Lydekker many years ago referred to a large-spotted race of leopard inhabiting Malaya. To this he gave the name *variegata,* Wagner. But Wagner, on his own admission, applied the name *variegata* to the Javan leopard, which had previously been called *melas* by Cuvier; and this ascription of *variegata* to the Sunda Island leopard was adopted by Fitzinger and Matschie.
Description.—The coat is short, smooth and silky, the hair being barely $\frac{1}{2}$ in. long on the back and $1\frac{1}{2}$ in. on the belly, and the tail is in no sense bushy. The colour is rich, almost rusty red in the middle of the back, paler at the sides, very much as in the skins from Kiukiang, but the rosettes are smaller than in *japonensis,* the largest being mostly $1\frac{1}{2} \times 1\frac{1}{2}$ in., although a few are about $1\frac{3}{4} \times 1\frac{3}{4}$ in., and are more closely set, more irregular in shape, thicker-rimmed and with much darker infuscate centres, all combining to give a darker appearance to the pelage. On the croup and thighs indeed the centres are so dark that the rosettes on these areas assume the form of solid spots. (Pl. XI.) Approximate measurements in the flesh: head and body 3 ft. $7\frac{1}{2}$ in., tail 2 ft. $7\frac{3}{4}$ in., total 6 ft. $3\frac{1}{4}$ in.
In its richer, darker colour and dusky rosettes, this skin differs very markedly from the one from Tonghoo described above.
This leopard, obtained by Mons. J. Delacour and Mr. W. Lowe, was shot on July 1st and was therefore in summer coat. No stress consequently can be laid on the shortness of the hair on the body and tail when comparing it with the Chinese skins obtained in autumn and winter. But it may be safely assumed that at Hué in Annam, leopards are short-coated throughout the year.
It is interesting to note that the short, smooth-coated skin from Kwantung (Canton), provisionally referred above to *japonensis,* seems to link, in a measure, this Annam race with typical *japonensis,* especially in the ashy or fuscous tint of the centre of the rosettes.
In Col. R. L. Kennion's book *By Mountain, Lake and Plain,* p. 267, 1911, Lydekker referred to the skin of a leopard from Siam belonging to Mr. C. Hose which he described as having very large jaguarine rosettes with inclosed spots. It is likely enough that this skin is another representative of *delacouri.*
All the leopards I have seen from the Malay Peninsula (Johore and elsewhere) were black specimens exhibited in Menageries. It seems that the percentage of black individuals gradually increases southwards. C. B. Kloss, for example, stated that 'south of

Malacca the black form practically replaces the spotted entirely' (*Journ. States Branch Royal Asiatic Soc.*, No. 53, p. 14, 1909). It is, I think, probable that these southern Malayan leopards are identical with the Javan race which is addicted to melanism. But the Javan skins I have seen do not agree at all with Lydekker's description of the Malayan leopard as large-spotted.

The measurements of the available skulls from the above-mentioned countries are as follows :—

	Inches				Millimetres		
Locality and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Canine
Huê in Annam, ♀, ad. ...	7·7	6·9	5—	2·2 × 1·2	24	16	14
Mt. Popa, Lower Chindwin, ♀, ad. ...	7·2	6·7	4·7	2 × 1·1	21	15	12
Tonghoo, ♀, ad. ...	7·7	7—	5·1 +	2·2 × 1·2	25	18	13
Ruby Mines, Burma, ♀, ad. ...	7·1	6·5	4·8	2·2 × 1·2	22	17	13
Perak, ♂, subadult ...	8·3	7·4	5·4	2·4 × 1·4	24	17	15

The skull of the type of *delacouri* from Annam agrees very closely in its measurements with that of the type of *bedfordi* from S. E. Shensi, the larger upper carnassial and canine tooth being probably attributable to less wear owing to its being a younger skull. Unfortunately the skull is abnormal, the frontal bones between the orbits being greatly swollen owing to the expansion of their sinuses due to some pathological affection, possibly the presence of nematode worms. This gives the skull a remarkably high appearance and may have affected the shape of the nasal bones which at their upper ends are much more rounded and less pointed than in the Chinese and Malayan skulls I have seen.

The other skulls recorded in the list call for no special comment.

THE PANTHER OF JAVA

Panthera pardus melas, Cuvier.

Felis melas, G. Cuvier, *Ann. Mus.*, 14, p. 152, 1809.

Felis pardus and *leopardus*, Temminck, *Mon. Mamm.*, pp. 92 and 99, (in part, Javan specimens).

Felis variegata, Wagner in Schreber's *Säug.*, *Suppl.* 2, p. 483, 1841.

Felis variegata, var. B. *nigricans*, *atro-maculata*, *id. loc. cit.*

Panthera variegata, Fitzinger, *SB. Kais. Akad. Wien*, 58, pt. 1, p. 473, 1868.

Panthera variegata, var. *nigra*, *id. op. cit.* p. 476.

Locality of Type.—Java. Type in Paris Museum.

Distribution.—Java and Kangean Island, possibly also the Malay Peninsula and Sumatra.

Notes on the synonymy.—The name *melas* was originally applied to a black leopard brought alive by Péron from Java to France where it ultimately fell into the hands of Cuvier who gave Péron the credit of the name. I have failed, however, to find a reference to it in any of Péron's works, and Cuvier must be regarded as the author. Temminck, who knew Javan leopards as well as others, did not distinguish the race from Java, but figured the skulls of a male and female from that island in support of his claim of the distinctness of the two species *pardus*, the panther, and *leopardus*, the leopard. Neither of these names, however, is admissible, both belonging to African leopards. Since Wagner cited *melas* as a synonym of *variegata* and *melas* is the older name, *variegata* must give way to it, although Wagner, like Fitzinger who followed him, no doubt thought *variegata* would stand for the normal spotted type. Wagner redescribed the black Javan variety as *nigricans*, *atro-maculata*, but it may be questioned whether *nigricans* has nominal status: but Fitzinger substituted *nigra* for *melas* preferring apparently the Latin to the Greek word.

Description.—Typically a rather small, dark, richly coloured leopard, the ground colour a deep reddish or rusty yellow on the back, paler on the flanks and dusky grey, lightly washed with buff on the limbs, the under side white. The rosettes are all small and close set, with the centres a little darker in hue than the ground tint. The coat is short but thick and rather harsh, and the tail is inclined to be bushy. Black varieties are common.

The British Museum has several skins of this race mostly collected by G. C. Shortridge for Mr. W. E. Balston in 1908. The typically coloured spotted skins closely resemble each other in tint and pattern.

(1 and 2) Panganderan on Dirk de Vries Bay, S. Java. A made-up skin of a sub-adult ♂, measuring in the flesh: head and body 3 ft. 7 $\frac{1}{5}$ in., tail 2 ft. 8 in., total 6 ft. 3$\frac{1}{5}$ in. The rosettes are about 1 × 1 in. in diameter and the interspaces about $\frac{1}{4}$ to $\frac{1}{2}$ in. wide. Also the made-up skin of a youngish female, measuring in the flesh: head and body 3 ft. 5 $\frac{1}{5}$ in., tail, 2 ft. 2 $\frac{4}{5}$ in., total 5 ft. 8 in.

(3 to 5) Tassikmalaja in Preanger, 1,145 ft. The made-up skin of an adult female measuring in the flesh: head and body 3 ft. 6 $\frac{4}{5}$ in., tail 2 ft. 4$\frac{4}{5}$ in., total about 5 ft. 11$\frac{1}{2}$ in. Also the flat, undressed skin of a male, without skull, and not measured in the flesh but measuring as it is: head and body 4 ft., tail 2 ft. 4$\frac{1}{2}$ in., total 6 ft. 4$\frac{1}{2}$ in. The age of this example is uncertain. The flat skin of a black specimen, apparently a male but without a skull and unmeasured in the flesh, measures: head and body 4 ft. 1 in., tail 2 ft. 11 in., total 7 ft. This skin is obviously stretched in the drying.

(6) Java. A black made-up skin, without skull, presented by Mr. J. Th. Hamaker and unmeasured in the flesh, now measures: head and body 2 ft. 10$\frac{1}{2}$ in., tail 2 ft. 4 in., total 5 ft. 2$\frac{1}{2}$ in.

Two out of the six available skins are black; but according to Jacobson this variety is much rarer in Java than the normally coloured animal (*Journ. Fed. Malay St. Museum*, x, p. 238, 1921).

Of the measurements quoted above only two, taken in the flesh, call for notice, namely, those of the sub-adult male from Panganderan and of the adult, but young adult, female from Tassikmalaja in Preanger. The male measured 6 ft. 3⅗ in. Perhaps he would have reached 7 ft. when fully grown. The female measured 5 ft. 11½ in. and was probably full sized. These dimensions indicate that this Javan panther is smaller than the Indian, the male being only about the size of the Indian female.

The following are the measurements of the available skulls. In the table I have included several skulls formerly the property of Prof. Lidth de Jeude of Utrecht in Holland. Although these skulls are unlocalized, I infer they came from Java with the tiger's skulls, belonging to the same owner, which although also unlocalized, could be determined as Javan by their characters.

Locality (or history) and Sex	Total length	Cond. basal length	Zygom. width	Nasals	Upper carnal	Lower carnal	Canine
Lidth de Jeude, ♂, ad. ...	8	7·5	5·4	2·4 × 1·3	23	16	14
,, ,, ,, ♂, subad.	7·6	6·9	5·1	2·3 × 1·2	24	17	15
Panganderan, ♂, subad.	7·5	6·8	4·9	2·2 × 1·2	25	18	14
Preanger, ♀ (just ad.) ...	7	6·5	...	...	22	...	14
Lidth de Jeude, ♀, ad. ..	7·2	6·5	4·7	2·3 × 1·2	23	17	15
,, ,, ,, ...	7·1	6·5	4·8	2·2 × 1·1	21	16·5	12
,, ,, ...	...	6·3	4·7	2·1 × 1·1	22	15	13
,, ,, ...	6·7	6·1	4·4	2 × 1	21	15	12
Panganderan, ♀ (not ad.)	6·5	5·9	4·3	1·9 × 1	22	14	12

These dimensions tell the same tale as those of the skins, namely, that the full-grown male of the Javan panther is approximately only as big as the female Indian panther.

In all the skulls it is noticeable that the nasals are narrowed and pointed at their upper ends and project slightly or considerably beyond the maxillæ.

Temminck, it may be added, figured two skulls, of an adult ♂ and an old ♀, Javan panther. The figures are stated to be half natural size; but there must, I think, be some error on that point, because when their measurements are doubled the male skull is only approximately 6·8 in. long and 5 in. wide, and the female 6·2 in. long and 4·2 in. wide. The figures indicate that the animals were full grown; but the skulls are smaller respectively than the young ♂ and ♀ skulls in my table.

This little leopard is known to me only from the Javan specimens described above and from the tail of one secured by G. C. Shortridge on Kangean Island to the east of Java. Attached to this tail is a label in Shortridge's handwriting giving the locality and stating that the animal also occurs on Paliat Island near Kangean and that Kangean is probably the eastern limit of *Panthera pardus,* which does not occur alongside the tiger in Bali. To the north-west of Java I know nothing of its distribution although I strongly suspect it is the same race as the panthers of at least the southern portion of the Malay Peninsula. The skull of a leopard recorded from Sumatra was figured by Blainville under the inadmissible name *sumatrana* (*Ostéogr.,* Atlas, II, Pl. VIII, 1839-1864); but it was sent to Paris by a collector, Duvaucel, whose localities are not above suspicion. The skull is 1 in. longer than the largest Javan skulls I have seen. In this connection it may be recalled that more than a century ago Sir Stamford Raffles, in his report on collections made in Sumatra, stated that only two species of cats were procured, namely, the tiger and the tiger-cat, a race of *bengalensis.* Tigers, he added, were very numerous, several varieties being distinguished of which one is the Rimau Kumbang or black tiger. Since panthers are frequently called tigers, this reference has been cited as evidence of the occurrence of black panthers in Sumatra.

On this point, however, Jacobson recently said that there is no authentic record of *Felis pardus* of the normal spotted type having been obtained in Sumatra, all reputed cases having proved to be Clouded Leopards (*Neofelis nebulosa*); and he believes that the so-called black ones shot at or seen were nothing but melanisms of this last mentioned species. This, he adds, is also the opinion of the well-known tiger hunter Ledeboer, whom I quoted when writing on the tigers of the Sunda Islands. Mr. Jacobson is resident in Sumatra; and until his testimony is refuted, it must be concluded that panthers, puzzling as the fact is, do not occur in Sumatra (see *Journ. Fed. Malay States Museum,* x, p. 238, 1921).

Summary of the Races of Asiatic Panthers

The following brief summary of the races of Asiatic and European panthers discussed in foregoing pages may be of interest:—

(1) The Russian Panther (*Panthera pardus ciscaucasica*). Described by Satunin as differing from the race of Asia Minor by its smaller size and paler colour, there being no reddish shade in the pelage. Recorded from the Province of Kuban in S. Russia, north of the Caucasus, this race is known to me only from its description.

(2) The Asia Minor Panther (*Panthera pardus tulliana*). A large panther inhabiting Asia Minor and Transcaucasian Russia, typically with large, thin rimmed, well spaced rosettes, pale reddish fawn in colour, and with a thick winter coat and bushy tail.

(3) The Persian Panther (*Panthera pardus saxicolor*). Akin to, and intergrading with, *tulliana,* but typically paler in colour, without the reddish fawn tint, and with smaller rosettes. Resembles the ounce in its colour and thick winter coat, and inhabits Persia from the shores of the Caspian Sea to the coast of the Persian Gulf and as far to the east as Seistan.

(4) The Sind Panther (*Panthera pardus sindica*). No doubt intergrading with the Persian race, but richer in colour, resembling apparently the Asia Minor race in this respect, as also in pattern, but carrying, it seems, a much coarser coat. Known, up to the present time, only from the Kirthar Range in Sind.

Note.—In connection with these four races from South-Western Asia and S. Russia, it is interesting to observe that the two pale Russian and Persian races (*ciscaucasica* and *saxicolor*) are apparently separated geographically by the more normally coloured Asia Minor race (*tulliana*), and that the two more normally coloured Asia Minor and Sind races (*tulliana* and *sindica*) are similarly separated by the pale Persian race (*saxicolor*). This suggests that the Russian and Persian races have independently acquired their pallid coloration and may be identical environmental races derived from a more normally coloured race represented by the forms now found in Asia Minor and Sind.

(5) The Indian Panther (*Panthera pardus fusca*). Very imperfectly known, probably several distinguishable races being grouped under the name *fusca*, which in the strictest sense belongs to a Bengalese type. On the available evidence this panther is a short and sleek coated animal, yellowish fulvous in colour, and with small close-set rosettes, thus differing sharply from the Sind, Persian and Asia Minor races. But in other parts of India, the colour may be richer or paler, the rosettes may be large, the pattern bold, and the coat tolerably long and rough.

(6) Millard's Panther (*Panthera pardus millardi*). A race from Kashmir, differing from typical *fusca* in having a thicker, softer, more furry coat, and in lacking the bright fulvous or rusty fulvous hue.

(7) The Amurland Panther (*Panthera pardus orientalis*). Smaller than the Persian and Indian races, with a luxuriant soft coat, a bushy tail, pale, creamy-buff colour and very large, widely spaced rosettes, with conspicuously darkened centres.

(8) Chinese Panther (*Panthera pardus japonensis*). Typically a Northern Chinese race, differing from the Amurland race in being very rich rusty fulvous in colour.

(9) Bedford's Panther (*Panthera pardus bedfordi*). A Chinese race differing from the foregoing in lacking the rich rusty fulvous hue and in having smaller, closer-set rosettes.

(10) Delacour's Panther (*Panthera pardus delacouri*). A race from Annam, recalling *japonensis* in colour but with the rosettes smaller and closer set and with darker centres, and the coat on the body and tail as short and sleek as in the typical Indian panther.

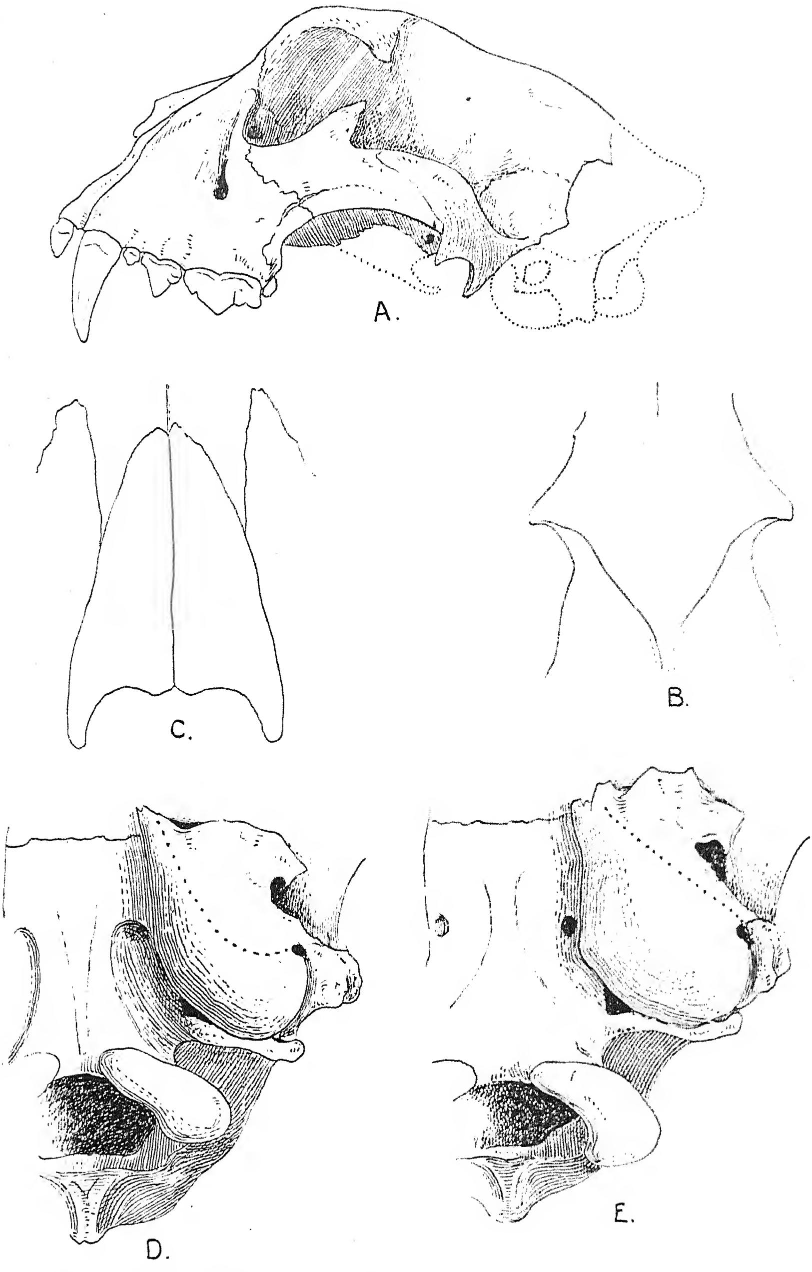
(11) The Javanese Panther (*Panthera pardus melas*). A small race inhabiting Java and Kangean Island, with a short, sleek coat, dark rich colour and small close-set rosettes.

The Ounce

(Pls. XII-XIII)

The Skulls of the Panther and Ounce

Since the alternative and perhaps more familiar name of the ounce is snow-leopard, it might be inferred that this animal is nearly



A. Skull of Ounce (*Uncia uncia*). Half natural size.
B. Summit of same from above. Half natural size.
C. Nasals of same. Natural size.
D, E. Left side of occiput and auditory bulla of Ounce and Panther, the position of the partition of the bulla indicated by dotted line. Natural size.

allied to the leopard or panther, certainly more nearly allied to it than the panther is to the lion or tiger. Most emphatically that is not the case. In the structure of the skull the ounce stands apart from the other three species, the skulls of which are very much alike and intergrade in all essential characters. The most obvious differences exhibited by the ounce's skull are the shortness of the muzzle, the elevation of the forehead, the vertical chin and less well-developed uprising posterior process, the coronoid, of the lower jaw. But a deeper seated difference is found in the structure of the bony swelling associated with the ear on the lower side of the skull and known as the auditory bulla. This swelling, when the skull is inverted, is the roof of a hollow which in all the Cat-family (*Felidæ*) is divided by a vertical bony partition into an outer and an inner chamber. In the ounce the two chambers are nearly equal in size, the outer being comparatively very large owing to the line of origin of the partition from the roof lying far inwards and remote from the auditory orifice. In the lion, tiger, panther and, it may be added, the American jaguar, the two chambers are very unequal, the outer being comparatively quite small owing to the line of origin of the partition from the roof lying externally and close to the auditory orifice. Less important than this difference, but still very noticeable, is the presence on the bone between the bullæ in the ounce of two deep depressions for muscular attachment. These depressions are quite shallow in the lion, tiger, panther and jaguar.

These differences, which I described some years ago (*Ann. Mag. Nat. Hist.* (8), xviii, p. 306, 1916), are illustrated on Plate XII which also shows the side view of the skull of the ounce, with some missing portions represented by dotted lines, the nasal bones, which are very short, and the interorbital region, from above. This imperfect skull, I may add, is the only example, so far as I am aware, in Great Britain. It has been in the British Museum for many years, but is unsexed and has no history. I do not know whether the male and female skulls of this species differ as do those of tigers, panthers and lions.

Kinship between the Ounce and the Lion, Tiger, Panther and Jaguar, which constitute the genus *Panthera*, is attested by the structure of the hyoid bone; but the differences in the skull, above pointed out, may be emphasized by referring the Ounce to a distinct genus for which, as I pointed out in 1916, the name *Uncia*, given to it by Gray, is available.

THE NAME, DISTRIBUTION AND EXTERNAL CHARACTERS OF THE OUNCE

Uncia uncia, Schreber

Felis uncia, Schreber, *Säugthiere*, iii, Pl. C. 1775; p. 586, 1777.
Felis irbis, Ehrenberg, *Ann. Sci. Nat.* xxi, pp. 394 and 410, 1830.
Uncia irbis, Gray, *Ann. Mag. Nat. Hist.* xiv, p. 394, 1854.
Felis uncioides, Horsfield, *Ann. Mag. Nat. Hist.* (2nd ser.) xvi, p. 105, 1855.

Distribution.—Central Asia: the Altai, Tibet and Himalayas.

Notes on the synonymy.—Under the name 'L'Once', Buffon published an unmistakable figure of the Snow-leopard (*Hist. Nat.* ix, Pl. XIII, 1761); and an acknowledged copy of this figure was produced by Schreber with the name *Felis uncia* engraved beneath. But early literature relating to the ounce contained so much confusion regarding the name, distribution and characters of the species that Ehrenberg, who also disapproved of admitting *onca* for the jaguar and *uncia* for the ounce, decided to abolish the name *uncia* in favour of *irbis*. But *uncia* being the older name must be adopted.

Buffon unfortunately recorded no locality for the skin he described as 'L'Once', the skin which was the type of *Felis uncia*, Schreber. But the skin Ehrenberg described, when he substituted *irbis* for *uncia*, came from the neighbourhood of the Altai Mountains. I propose, therefore, to designate the Altai Mountains as the locality of the typical ounce. At present such a designation is of no great moment because there is not a sufficient number of properly localized skins and skulls to show whether the species has become differentiated into subspecies or not. It is a long way from the Altai to the Himalayas. Hence it would not be surprising if the ounces of the two ranges proved distinguishable. In that case the name *uncioides* given by Horsfield to one of Hodgson's skins from Nepal will be available for the Himalayan form.

Distribution.—The known distribution of the ounce is the high tableland of Central Asia from Tibet northwards to the Altai and southwards to the Hindu Kush and the Himalayas. According to Major Burrard (*Big Game Hunting in the Himalayas and Tibet*, p. 222, 1925) it extends from the Hindu Kush on the west to the extreme eastern end of the Himalayas, is abundant in the Zaskar Range and is found in limited numbers a few miles along the Dhauladhar and Pir Panjal Ranges from their junctions with the main Himalayan Range. Its distribution in Eastern Asia is not known. Although its imported skins are common in China, there is no evidence of its occurrence in that country, but it may, according to Sowerby, penetrate the south-western portions from the Himalayas.

It has been recorded from Manchuria and Amurland; but, as explained above, this record is probably attributable to identification of skins of the pale, large-spotted thick-coated panther (*Panthera pardus orientalis*) as those of the ounce. Its occurrence in the Caucasus, Armenia and even South Persia has also been asserted; but in these parts of Asia it has certainly been confused more than once with the local panthers (*P. pardus tulliana* and *P. p. saxicolor*).

No doubt one of the sources of the belief in the existence of the ounce in Southern Persia was the illustration and description of an example by Hamilton Smith (*Griffith's Animal Kingdom*, ii, p. 469, 1827), an example exhibited in the Tower Menagerie and alleged to have been captured on the shores of the Persian Gulf. If the locality was correct the animal was not an ounce but a Persian panther (*P. pardus saxicolor*) which Hamilton Smith wrongly identified. But since his figure and description apply to an ounce,

he must have drawn his illustration and description from a skin of that animal not from the living specimen.

Description.—As a representative of this species an adult mounted specimen ticketed Tibet and exhibited in the British Museum, may be selected for description.

The coat is moderately long and full but lies smoothly, is not especially woolly and shows no sign of tufting. On the flanks the hairs are about 1 in. long, on the belly and tail about 2 in., the tail being uniformly bushy throughout. On the head the hair is quite short, and there are no fringes on the cheeks.

The general colour is pale grey, blending without contrast with the white of the underside; but the centres of the thin-rimmed rosettes are a darker grey. On the head and nape the spots are solid and black, passing into rosettes on the shoulders and back where they become gradually larger and paler. On the hinder part of the back and loins there is an irregular median black stripe, formed of confluent solid spots, and on each side of this are two tolerably definite rows of elongated more or less confluent rosettes exhibiting a linear arrangement, the rosettes of the outer row being less lengthened and less confluent than of the inner. On the flanks and thighs the rosettes are large and spaced, about $2\frac{1}{4} \times 2\frac{1}{4}$ in. in diameter. On the legs the spots are solid and black, diminishing in size below; the fore paws are spotted, but the hind paws are spotless and the area below the hock behind is covered with a mat of whitish hair. Except for a few large solid blotches on the belly, the whole of the under side is white in the middle from the chin backwards. The tail also is white below, but above it is marked in its basal third with five rows of spots continuous with those of the loins; in its median part this linear arrangement disappears and in its terminal third the rosettes fuse to form broad transverse bands separated by white stripes.

The specimen above described is evidently in summer coat; and Dr. Cuthbert Christy has a similar skin from Srinagar. A smaller example in winter coat but without locality has the hairs erect and longer, reaching 2 in. on the body, and the cheeks carry a thick fringe of which the hairs are 2 in. long. On account of the greater length of the hair, the pattern is less definite on the body, but it is conspicuous and black on the head, limbs and tail. Another winter skin labelled Tibet has the coat thick, woolly and tufted and the pattern very indistinct. A woolly tufted coat and obscured pattern are also exhibited by a flat skin from Simtola.

In connection with the seasonal changes it may be noted that the tail remains uniformly thick and bushy throughout the year and that the pads on the paws are never in any sense overgrown or overlapped by hairs as might be expected of an animal that must frequently have to traverse ice and snow in winter.

The most marked variation in general colour is shown by an unlocalized skin procured from the East India Company. It is a beautiful creamy buff, with grey centres to the rosettes which are black-rimmed and well defined because the coat is smooth and not broken into woolly tufts.

The skin of a cub, probably about a month old and found by

Col. F. M. Bailey at Gang-tse in Tibet is particularly interesting. The coat is thick and wooly and the ground colour a dark dusky brownish grey. The fore quarters and head are rather confusedly and sparsely spotted and mottled with black and on the flanks and thighs there are big black spots with slightly paler centres. But particularly noticeable are three black bands, mostly undifferentiated into spots extending along the hinder portion of the back to the root of the tail. In front these bands are broad and close set, making an almost continuous black shield but still more to the front they break up into three large, detached black blotches. Towards the root of the tail the bands become narrower and divergent. The under side is white, with a few blotches on the belly.

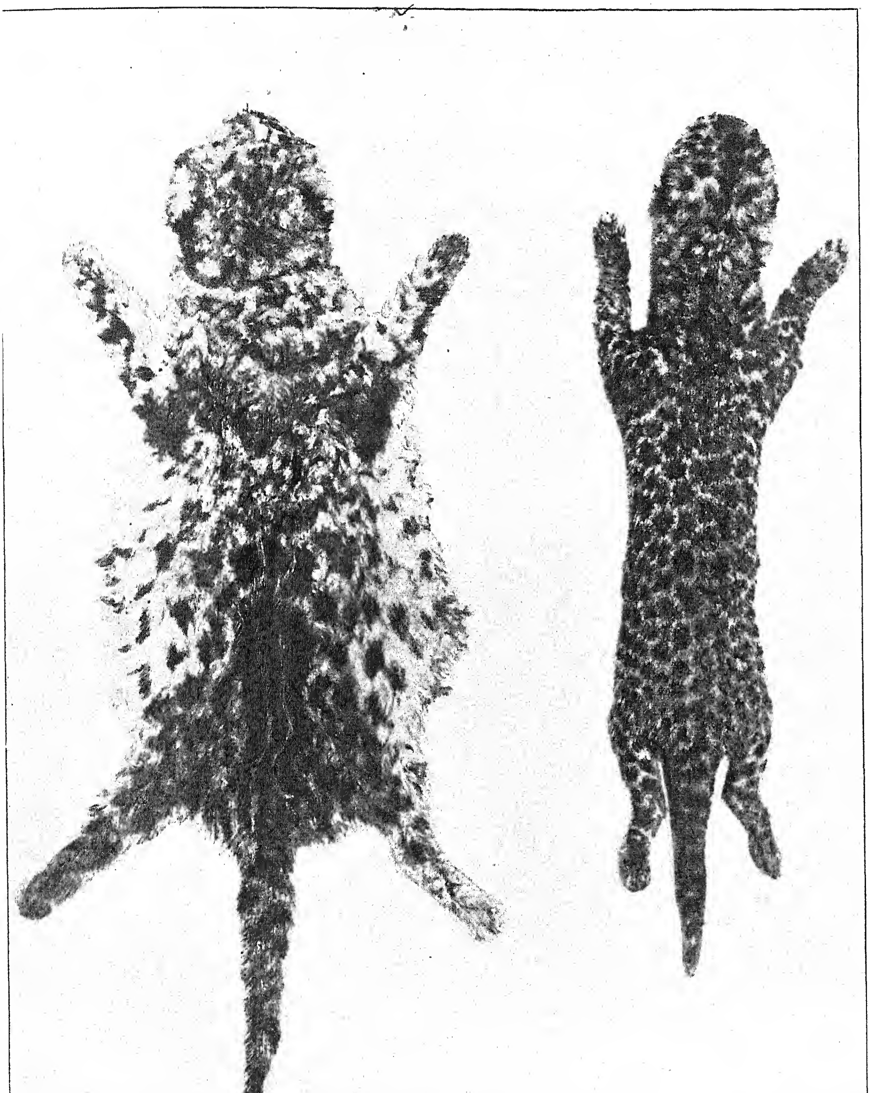
So far as I am aware the cub of the ounce has never previously been described or figured. It is strikingly different from panther cubs at any age, especially in the large size and sparseness of the spots, the presence of the three broad dorsal stripes and the thickness and length of the coat. Panther cubs are uniformly and closely spotted all over, both above and below, and the coat is comparatively short.

This ounce cub, with a panther cub alongside for comparison, is figured on Pl. XIII. An interesting point to note is that the presence of the dorsal stripes in the cub suggests that the pattern of the same region in the adult is due to the breaking up of longitudinal stripes, not to the confluence of rosettes. This is in keeping with the theory that the pattern of the Cat-family consisted originally of longitudinal black stripes.

Although the pattern in adult ounces is of the same type as that in panthers, there are certain differences. Blanford says, 'The rosettes are much larger than in leopards.' This is by no means always the case. But they are fewer in number everywhere and more spaced, and there are only a few on the fore part of the belly. No panther is spotless below on the throat, chest, the greater part of the belly, or the under side of the tail or on the hind paws; and the back of the hind leg below the hock is ashy or blackish in panthers, not whitish as in the ounce. Also the hairs on the neck in the ounce are not reversed in direction of growth as they are in all the panther skins, except two, which I have seen.

The only measurements of ounces taken in the flesh with which I am acquainted are mentioned in Rowland Ward's *Records*, 1928, p. 486, where the total dimensions from nose tip to tail tip are given. These I have entered in the following table together with the lengths of the head and body and of the tail, taken separately, of some of the skins in the Natural History Museum and of one recorded by Ehrenberg. Possibly these skins are stretched, but they probably serve to show approximately the average proportion that the tail bears to the head and body.

These measurements indicate that although the total length is about the same as in Panthers, the tail is longer and the head and body shorter comparatively in the ounce. Buffon, however, described a skin with the head and body measuring 4 ft. and the tail 3 ft.; and Blanford, on unstated authority, gives 4 ft. 4 in. and 3 ft. as the approximate lengths of the head and body and of the tail



Flat skin of Ounce cub—left.
Made-up skin of Panther cub—right.

Locality and Sex	Head and body		Tail		Total	
	Ft.	In.	Ft.	In.	Ft.	In.
Mt. Altai, flat skin (Ehrenberg), ♀ ...	3	8	3	0	6	8
Tien Shan, in flesh (Ward) ...	...	...	...	...	6	8
Kashmir, ,, (Ward) ...	...	...	...	...	6	8
Chitral, ,, (Ward), ♀ ...	...	...	...	...	6	5
Simtola, flat skin (Brit. Mus.) ...	3	11	3	2	7	1
Tibet, ,, (Brit. Mus.) ...	3	5	2	11	6	4
,, mounted (Brit. Mus.) ...	3	8	3	3	6	11

respectively, the tail in the latter case being relatively only a little longer than in Panthers. Other measurements may be found in the works of early writers. I have not, however, repeated them because ounces and panthers were not always discriminated a century or so ago.

As regards the skull, no complete measurements of a single specimen are known to me. In the following table I have recorded some of those presented by the skull in the Natural History Museum; but owing to the absence of the whole of the occipital region, the total and condylo-basal lengths can only be estimated roughly. To the table have been added the length and breadth measurements of two localized skulls mentioned in Rowland Ward's *Records,* 1928, p. 486, and of an unlocalized skull referred to by Elliot in his *Monograph of the Felidæ.*

	Inches				Millimetres		
Locality and History	Total length	Cond. basal. length	Zygom. width	Nasals	Upper carnal	Lower carnal	Upper canine
Nat. Hist. Mus. Loc. ?...	? 7·3	? 6·5	4·9	1·8 × 1·2	23	17	11
Elliot, Loc. ? ...	6·5	...	4·9–	...	...	...	...
Ward. Baltistan ...	7·7+	...	5·2+	...	...	..	...
,, Kashmir ..	7+	...	4·9	...	...	..	...

The distinguishing characters of the skull as compared with that of Panthers, Tigers and Lions have already been discussed above. I may add, however, that I can find no evidence supporting Lydekker's statement (*Game Animals of India, Burma and Malaya,* p. 324, 1924) that the palate is more swollen than in those species,

In the skull in the British Museum all that remains of the palate, which is the greater part of it, is flat. The posterior part towards the posterior nares is missing, it is true; but the skull of two specimens, formerly in the Zoological Society's Museum, which I examined, showed no swelling of any part of the palate. Moreover, the area of the palate just in front of the nares is frequently swollen in Panthers.

It would be unreasonable to expect sportsmen to part with Ounces' skins for the national collection, although they are greatly needed. But I venture to put in a plea for skulls which are equally, if not more, wanted and are neither valuable, beautiful nor imposing as trophies.

NOTES ON THE BIRDS OF THE UPPER BURMA HILLS.

BY

P. F. WICKHAM.

PART III.

(*Continued from page 63 of this volume.*)

XLVIII.—Family ÆGYPIDÆ.

561. The Black or Pondicherry Vulture. Sarcogyps calvus.

Common in all these Hill Tracts up to about 3,000′ but breed even at a lower level than this. I took an egg of this bird in the Southern Shan Hills at about 1,200 ft. elevation in early January.

562. The Northern Long-billed Vulture. Gyps indicus nudiceps.

563. The Indian White-backed Vulture. Pseudogyps bengalensis.

Both these species of vulture inhabit Burma and presumably the hill tracts, but they breed only at low elevations. Nests in Shan Hills early in January.

XLIX.—Family FALCONIDÆ.

564. The Eastern Peregrine Falcon. Falco peregrinus calidus.

Probably a winter visitor to the Hills of Burma.

565. The Shahin Falcon. Falco peregrinus peregrinator.

Also a winter visitor to the Hills of Burma. Apparently the distribution of this bird as described in the *Fauna* intends the North-east Hills of Burma, i.e., the Shan and Kachin Hills to be omitted as a habitat of this bird even in winter. Mackenzie records it from the North Chin Hills.

566. The Laggar Falcon. Falco jugger.

This bird breeds in the dry zone of Burma and would be found in the foot-hills.

567. The Burmese Hobby. Falco severus severus.

Recorded from the Chin Hills low elevations and I can record it from the Southern Shan Hills where it was, I am sure, breeding in the crags at Taunggyi, early in March. Bonelli Eagles (*Hieraëtus fasciatus* (?)) were building at the time and one of these little falcons regularly mobbed the big eagles on their appearance. After a short time, as no attention was paid to the insults, the little falcon would stop mobbing and fly back to his perch, a rock on one of the highest points. I could not discover where the nest was exactly.

568. The Burmese Red-legged Falconet. Microhierax cærulescens burmanicus.

We have now three species of Falconets called Black, Red and White-legged, but all really having black legs. I remember well being puzzled about the absence of the red legs when I first came across this little hawk, which had stooped and killed a small bird within a few feet of me and taken it up to its perch on a telegraph wire. The names are given on account of the colouration of the thigh coverts, a point one is apt to miss. It is a fearless little hawk and I noted it stoop and kill a grasshopper within three or four feet of me sitting in a verandah of a house, the grasshopper being just off the verandah. Also, I once rose one off the ground where it had been feeding on a pipit, *Anthus*

rufulus, which had evidently been too big to carry off. This bird flew into a tree close by and sat there for some time allowing a Shan with me to fire at it several times with a pelletbow.

569. Fielden's Hawk. Neohierax insignis insignis.

In my experience a bird of the Dry Zone of Burma only, but might be found in the foot-hills of the Chin and Shan Hills. Grant found the eggs, I believe, in the plains near the Chin Hills.

570. The Eastern Red-legged Falconet. Erythropus amurensis.

A migrant in the Shan Hills only passing through. As the *Fauna* says, 'They migrate in enormous numbers which must be seen to be appreciated.' It is truly a wonderful sight to see hundreds of these pretty hawks catching 'Termites'; they perch when tired seemingly, on quite low bushes.

They pass through the Shan Hills in April, vide my note in the *Journal*, vol. xxix, p. 292. I never saw them in Chin Land.

571. The Himalayan Kestrel. Cerchneis tinnunculus interstinctus.

572. The Burmese Kestrel. Cerchneis tinnunculus saturatus.

The former probably the Chin Hills subspecies of Kestrel; the latter the eastern Kachin Hills and Shan Hills form. I never found it breeding nor is it noticeable in the breeding season, but in the winter months it is numerous and if you want to see a number of them together, you have only to set fire to a patch of grassy jungle when they soon appear to catch the grasshoppers, swooping almost into the burning grass. I have counted thirty or more at a time when a jungle fire has been in progress only a few minutes when there was not one just before the fire started.

573. The Eastern Steppe Eagle. Aquila nipalensis nipalensis.

I have certainly seen this eagle in the Shan Hills at the lower elevations in forests and it probably occurs also in the Kachin and Chin Hills.

574. Bonelli's Eagle. Hieraëtus fasciatus fasciatus.

575. The Booted Eagle. Hieraëtus pennatus.

Both these eagles occur in our hills. A nest, which I ascribed to the former species on the crags at Taunggyi, Southern Shan Hills, contained fully-fledged young in April. The next season the birds were building again, but one must have been shot as after a few days' watching they suddenly disappeared. The nest with young was accessible, but the second nest begun was on a very difficult ledge and I do not think I could have obtained the eggs. They were reported to be bold raiders of the local hen roosts; hence I expect the tragedy.

Harington records seeing Bonelli's Eagle in the Northern Shan Hills.

576. The Indian Black Eagle. Ictinaëtus malayensis perniger.

Recorded by Mackenzie from the North Chin Hills and Harington from the Kachin Hills.

577. The Changeable Hawk Eagle. Spizaëtus cirrhatus limnaëtus.

One of the most common of our eagles in these hills. Nests.

578. The Chinese Hawk Eagle. Spizaëtus nepalensis fokiensis.

Probably Shan and East Kachin Hills.

579. The Burmese Crested Serpent Eagle. Spilornis cheela burmanicus.

Chin, Kachin and Shan Hills. Nidification recorded by Mackenzie in the Chin Hills. A single egg.

580. The Rufous-winged Buzzard Eagle. Butaster liventer.

A very common bird in the Shan Hills and recorded also from the Kachin Hills. I notice the *Fauna* states its breeding has been recorded in Pegu. So I cannot say this is only a hill bird and *Butaster teesa* the plain species of Buzzard Eagle. I found numerous nests in the Shan Hills, sometimes quite conspicuous, nests in solitary trees in paddy fields and not too high; also nesting in the fork at the top of an oak tree in jungle.

A specimen I shot had a whole lizard in its gullet. It has an unmistakable cry often uttered in the breeding season and on the wing—a slow laboured flight.

581. **Pallas's Fishing-Eagle. Haliaëtus leucoryphus.**

Recorded by Harington as breeding on the banks of the Irrawaddy River in Kachin country.

582. **The Himalayan Grey-headed Fishing-Eagle. Icthyophaga humilis plumbeus.**

Probably a bird of the Kachin country also but, there seems no record of it. I have never seen any fishing-eagles on the larger hill rivers of the Shan and Chin Hills.

583. **The Brahminy Kite. Haliastur indus indus.**

A rare bird in the hills and only to be found near lakes and the largest rivers.

584. **The Common Pariah Kite. Milvus migrans govinda.**

Not so common in the hills as in the plains although they breed and a pair are generally noticeable round any big village in the open season. They leave Burma in the rains for China and return about the same time as one of the big Bhuddist festivals : hence they are called 'Praying birds'. Their appearance at this time marks the near approach of the end of the rainy reason. Like the Marsh Harrier, they sometimes pick up a wounded snipe, and an instance is recorded of one retrieving a shot woodcock for a sportsman although the kite had to be shot at to make it drop the bird.

585. **The Black-eared Kite. Milvus migrans lineatus.**

Said to occur in our Burmese Hills.

586. **The Black-winged Kite. Elanus cæruleus vociferus.**

I have certainly seen this species at 3,000 ft. in the Shan Hills, but they are decidedly uncommon.

587. **The Pied Harrier. Circus melanoleucus.**

I can at least record this species of harrier in the Shan Hills as a winter visitor. October to April.

588. **The Marsh-Harrier. Circus æruginosus æruginosus.**

A winter visitor to suitable places in the hills, such as marshy country round a lake, but very rare.

589. **Hume's or The Burmese Shikra. Astur badius poliopsis.**

In all these hills but by no means common. Nests as described in the *Fauna* for this species. They breed middle of April in the Shan Hills.

590. **The Crested Goshawk. Astur trivirgatus trivirgatus.**

Recorded by Mackenzie from the North Chin Hills and Harington in the Kachin Hills.

591. **The Sparrow-Hawk. Accipiter nisus.**

Now divided into two subspecies *nisosimilis* and *melanoschistus* both of which occur in Burma and they will inhabit our hills.

592. **The Northern Besra Sparrow-Hawk. Accipiter virgatus affinis.**

A probable inhabitant of Northern Burma.

593. **The Eastern Sparrow-Hawk. Accipiter gularis stevensoni.**

Occurs in the North Burma Hills.

594. **The Indian Crested Honey-Buzzard. Pernis ptilorynchus ruficollis.**

Chin, Kachin and Shan Hills.

595. **The Burmese Black-crested Baza. Baza leuphotes burmana.**

The description of the taking of the nest of this bird in the Shan Hills by Harington, vol. xxi of the *Journal*, p. 587, is very interesting.

596. **Blyth's Baza. Baza jerdoni jerdoni.**

Evidently a rare bird but occurring in these hills.

L.—Family COLUMBIDÆ.

597. **The Burmese Green Pigeon. Crocopus phœnicopterus viridifrons.**

Common in all these hills, nesting early in the year February. As mentioned in the *Fauna*, there is no better sport than that afforded by these pigeons flighting, if one can mark their lines of flight. They frequent the hills at elevations considerably greater than 2,000 ft. and I am sure they nested on the Taunggyi Crags at nearer 5,000 ft.

598. **The Ashy-headed Green Pigeon. Dendrophasa pompadora phayrei.**

Chin Hills certainly, but I am not sure of its occurrence in the Shan and Kachin Hills.

599. **The Siam Orange-breasted Green Pigeon. Dendrophasa bicincta praetermissa.**

I have only shot this bird near Rangoon and in Tennasserim, but it may occur in the Southern Shan Hills and apparently Harington found it in the Kachin Hills.

600. **The Thick-billed Green Pigeon. Treron curvirostris nipalensis.**

Shot one out of a crowd on the east of the Salween River, Shan Hills: they must also inhabit the Chin and Kachin Hills.

601. **The Pin-tailed Green Pigeon. Sphenocercus apicaudus apicaudus.**

Quite plentiful in the Chin Hills and occurs in the Kachin Hills, but I never came across it in Shan land.

602. **The Grey-headed Imperial Pigeon. Ducula badia griseicapilla.**

Common in the Chin Hills, recorded also from the Kachin and Shan Hills; a bird of the higher hills, say 5,000 feet, in ever green jungle.

603. **The Indian Green Imperial Pigeon. Muscadivora ænea sylvatica.**

Chin, Kachin and Shan Hills—of low elevations only. The Burmese name should, I think, read '*hnet-nga ngwa*' not as given in the *Fauna*.

604. **The Indian Emerald Dove. Chalcophaps indica indica.**

Universal in our hills in suitable places. Shady glades.

605. **The Indian Blue Rock-Pigeon. Columba livia intermedia.**

Only to be found in the foothills.

606. **The Ashy Wood-Pigeon. Columba pulchricollis.**

Shan Hills and probably also the Chin and Kachin Hills.

607. **The Purple Wood Pigeon. Alsocomus puniceus.**

Very local in the Shan Hills where I have shot it at about an elevation of 3,000 ft.; it does not seem ever to be found in any numbers together even when feeding. I did not notice it in the Chin Hills and it is not recorded from the Kachin Hills that I can find.

608. **The Speckled Wood Pigeon. Dendrotreron hodgsonii.**

A bird of high elevations so far as my experience goes, rare and very wild—Chin Hills where I came across it. Shan Hills where I saw a skin from the Chinese frontier.—Kachin Hills.

609. **The Indian Rufous Turtle-Dove. Streptopelia orientalis meena.**

A common dove in all our hills, feeding in the paddy field stubbles with the spotted dove and at other times feeding on the ground in jungle.

610. **The Burmese Spotted Dove. Streptopelia chinensis tigrina.**

Chin and Shan Hills. Common and has many enemies as it makes a toothsome curry and soup. The Shans trap them and sell them in their five-day bazaars; they are favourite cage birds.

Eggs can be taken any month in the year, I should think. I have seen nests practically on the ground and also a parent bird once shammed a broken wing for my benefit.

611. **The Yunnan Spotted Dove. Streptopelia chinensis forresti.**

Under nidification in the *Fauna*, the place Myingyan, where Harington is said to have found it breeding freely must, I think, be wrong ; it may be a misprint for Myitkyina, Kachin Hills, by the context.

Not apparently found in the Chin or Shan Hills.

612. **The Burmese Red Turtle-Dove. Œnopopelia tanquebarica humilis.**

A common bird in all these hills, but is apparently migratory locally as it is more common at some seasons of the year than at others.

613. **The Bar-tailed Cuckoo-Dove. Macropygia unchall tusalia.**

Recorded by Mackenzie from the North Chin Hills : also he found it breeding there.

614. **The Burmese Little Cuckoo-Dove. Macropygia ruficeps assimilis.**

Said to occur in the South of the Shan Hills.

LI.—Family Phasianidæ.

615. **The Burmese Pea-fowl. Pavo muticus.**

The peafowl does not occur often much above 3,000 ft. in these hills and it is commoner in the plains or foothills than at 3,000 ft. In the Shan Hills they are fairly plentiful, in the larger river valleys specially. A young peafowl is the best table bird I have ever eaten. The Shans can generally obtain one for you if required, but do not shoot them very often for their own consumption, probably because a charge of powder and shot is expensive and they would sooner shoot a barking deer with it than waste it on a peafowl.

When driven, they run one behind the other and will not rise if they can help it. They come out on the roads to peck about and show like other game birds little if any consternation at a motor car ; but when once scared and put up, it is very difficult to come up with them again.

616. **The Burmese Peacock-Pheasant. Polyplectron bicalcaratum bicalcaratum.**

Inhabits the Chin and Kachin Hills but by no means common anywhere : in fact one seldom hears of their being shot. I expect it inhabits the Shan Hills also in places, but as a rule the jungle is not thick enough for them and they may have become extinct in these parts.

617. **The Burmese Jungle Fowl. Gallus bankiva robinsoni.**

I should have said the breeding time for the Jungle Fowl commences at the end of March both in the plains and hills. Jungle fires no doubt in Burma play havoc with the breeding of this bird and eggs can be taken after the rains have commenced at the end of May due to the destruction by fire of the first nest. The hen shows no fear of man when her young are about.

As soon as the paddy is cut and threshed Jungle Fowl collect and descend easily in the mornings and later in the evenings to feed in the stubble, spending the heat of the day and roosting in adjacent jungle, sometimes in the day time resting in trees as at roosting time, at other times they are not so gregarious and the cocks are often met with singly in the jungle. They are captured in noozes by all tribes with call birds.

I cannot remember the exact number, but I knew both the guns who bagged well over 50 brace of these birds in a day in the Chin foothills.

618. **Mrs. Hume's Pheasant. Syrmaticus humiæ humiæ.**

The barred-back pheasant of the Chin Hills is a bird of the hills only, and steephill sides at that. The *Fauna* says its flight is low ; it could have added ' and also straight down hill when risen '.

Like the Kalij Pheasants and Wood-Partridges they often perch in trees when put up by dogs and are then easy to get a shot at. They rise with an easily recognizable chuckle,

619. **The Burmese Barred-back Pheasant. Syrmaticus humiæ burmanicus.**

As above, but inhabits the Eastern Hills of Burma: they are quite common near the summit and on the eastern slopes of the Taunggyi crags, Shan Hills. A shy pheasant.

620. **Stone's Pheasant. Phasianus elegans.**

Kachin and Shan Hills. I have seen a skin said to have been taken in the Shan Hills but have never come across them myself in the wild state. They must, I think, be rare.

621. **Lady Amherst's Pheasant. Chrysolophus amherstiæ.**

As above for Stone's pheasant, but this bird is even more rare. I saw parts of the skin of a male obtained near the eastern boundary of the North Shan Hills.

622. **The Siam Fireback. Lophura diardi.**

Southern Shan States. A rare bird.

623. **The Black-breasted Kalij Pheasant. Gennæus horsfieldii horsfieldii.**

It would not be easy to get a true typical *G. h. horsfieldii* in Burma I think. The birds in the Chin Hills, so far as my experience goes, seem to be the next subspecies. However Mackenzie considered he obtained this bird in the extreme north of the Chin Hills and Hopwood in Arakan near the Chittagong border and it may probably encroach into Burma on our extreme western limit. Its record from the Irrawaddy River valley Bhamo Kachin country is very curious.

624. **William's Kalij Pheasant. Gennæus horsfieldii williamsi.**

It is very satisfactory that many species, of these pheasants named by Mr. Oates, have now all been included under the one subspecies since Mr. Stuart Baker evolved order out of chaos in his revision of this Genus in 1915. I notice the subspecies *cuvieri* has also now been given up. Inhabits all our western hills.

These pheasants do not afford much sport to the gun, but this is probably the fault of the hilly country they inhabit being difficult to drive. In the early morning in the cold weather these pheasants are met with on the cart tracks and in open paddy stubble, but they are generally met with in heavy jungle and run, if there is time to get away, rather than fly. Till the breeding season commences they can be found feeding together, cocks and hens, to the number of 20 or more, but separate widely on being disturbed. The male from records, evidently helps rear the chicks and the species generally likes to be near water. I have never recognized the call, but both sexes have an easily recognizable chuckle when put up.

Roughly this bird inhabits the Chindwin River valley from Homalin to Pakokku and extends further south to the west of the Irrawaddy River as far as Minbu.

625. **The Burmese Silver Pheasant. Gennæus lineatus lineatus.**

In these hills this is the Kalij which inhabits the country unoccupied by *G. horsfieldii*, i.e. the Shan Hills. In the *Fauna* the account of the distribution is difficult to follow on account of the spelling of the names. Kongtong should read Kengtung, an easily recognizable error.

626. **The Yunnan Silver Pheasant. Gennæus nycthemerus ripponi.**

This species, to me, the real silver pheasant, occupies our eastern hills—the inter-Salween country.

627. **The Ruby Mines Silver Pheasant. Gennæus nycthemerus rufipes.**

Occupying the rest of the Shan Hills, i.e., between the Salween River and the Irrawaddy River.

There is no mistaking the male *nicthemerus* from all other silver pheasants. When one sees it in the jungle it looks like a roll of cotton wool or a white bushy tailed cat running about. Personally I do not agree with the description of its habits in the *Fauna*. Its occurrence in open grass lands amidst stunted oaks is not my idea of its habitat which differs in no way from other Silver

or Kalij pheasants except perhaps that it keeps to higher elevations about 4,000 ft., but I have seen it a good deal lower than this.

It is fond of coming out in the early mornings to peck about on not too frequently used camping grounds and on the hill pack mule paths along which it runs for some distance before seeking cover.

They seem local in distribution but this like the open grass lands is probably a question of food supply.

The illustrations in the *Fauna* of all these Silver pheasants are disappointing in my humble opinion.

628. **The Grey-bellied Tragopan. Tragopan blythii blythii.**

Inhabits the higher peaks of the Chin Hills, the elevation at which I have met with them being about 7,000 ft. in heavy evergreen forests. I never came across it as far south as Mt. Victoria, but that doesn't mean it does not occur there.

629. **Temminck's Tragopan. Tragopan temmincki.**

The species in the Kachin Hills.

630. **The Yunnan Bamboo-Partridge. Bambuscicola fytchii fytchii.**

Found in the Kachin and Shan Hills.

631. **The Assam Bamboo-Partridge. Bambusicola fytchii hopkinsoni.**

The subspecies inhabiting the Chin Hills.

The habits of these two subspecies are similar.

The Bamboo-Partridge keeps in coveys and sometimes gives quite sporting shots often lying well on the grassy hill sides which they frequent; they are seldom however found far away from water.

Their call is a curious chatter and sounds if most of the covey were shouting and like the English partridge they generally 'scream' a bit when put up by dogs or walked up by the guns.

Perhaps in the Shan Hills I have occasionally found them at a lower level than in the Chin Hills, but I think they can be found anywhere between 1,500–5,000 ft., preferably about 3,500 ft.

632. **The Blue-breasted Quail. Excalfactoria chinensis.**

Ubiquitous and, I think, rather more common during the rains when it breeds, in the hills, than at other times.

633. **The Japanese Grey Quail. Coturnix japonica.**

Recorded by Harington as occurring in the Kachin Hills.

634. **The Black-breasted or Rain Quail. Coturnix coromandelica.**

The Shan Hills are the only hills in Burma where I have met with them and then very local and only on the plateaux. They arrive in April when they commence breeding and were almost common round Taunggyi at about 4,500 ft. and commoner still in some broad valleys below at 3,000 ft. but not so common even then as in the Dry Zone in Burma during this time of the year. In Burma one often met with them in coveys, rising like miniature partridges. Their call or whistle very aptly expressed by *whit-whit*, *whit-whit*, constantly repeated, is ventriloquial.

635. **Ogilvie-Grant's Hill Partridge. Arborophila torqueola batemani.**

Chin and Kachin Hills—Very common in well wooded nullahs with plenty of evergreen growth; but near military outposts garrisoned by Ghoorkhas they were soon thinned as they are easily called up and snared. I tried once or twice to keep them in captivity but they never flourished and were always wild.

636. **The Arakan Hill-Partridge. Arborophila rufogularis intermedia.**

Chin and Kachin Hills: common in suitable localities but not so common in the Shan Hills as the shady jungly nullahs are not so frequent. I am not sure whether this subspecies or the next is not the one I have seen near the Ruby mines in the North Shan Hills and Kengtung in the south-east as I missed the only shot I took.

637. **The Tennasserim Rufous-throated Hill Partridge. Arborophila rufogularis.**

Both *rufogularis* and *torqueola* will occupy the same nullah and extend further south than Mount Victoria in the Chin Hills.

638. **The White-cheeked Hill-Partridge. Arborophila atrogularis.**

I think this species must be considerably less common than the two above mentioned. I never obtained it although it is apparently to be found in the Chin, Kachin and Shan (Ruby mines) Hills. Mackenzie records it from the North Chin Hills.

639. **The Brown-breasted Hill-Partridge. Arborophila brunneopectus brunneopectus.**

Eastern Burma Shan Hills.

640. **The Green-legged Hill-Partridge. Tropicoperdix chloropus.**

Kachin Hills.

641. **Phayre's Burmese Francolin. Francolinus pintadeanus phayrei.**

Can be found in all our hills up to at least 5,000 ft. elevation although perhaps commoner in the drier areas. They call more often than not from a tree and all the year round especially in the early morning and at dusk and when breeding. 'Be quick Papa' expresses the call. They breed early, March, a good many nests being destroyed by jungle fires. Nesting under a bush, in a hedge and even in open grass and like the English partridge but never seem to have so many eggs—5 or 6 being the usual number.

LII.—Family Turnicidæ.

642. **The Burmese Bustard-Quail. Turnix suscitator plumbipes.**

Chin and Kachin Hills, in the north replaced by the common Bustard Quail *Turnix suscitator taijoor*.

643. **The Chinese Bustard-Quail. Turnix suscitator blakistoni.**

S. Chin Hills and Shan Hills.

644. **The Little Button Quail. Turnix dussumieri.**

I identified this species near Taunggyi at about 3,000 ft. elevation. Shot off the nest.

645. **The Burmese Button-Quail. Turnix maculatus maculatus.**

All our Hills.

LIII.—Family Rallidæ.

646. **The Indian Blue-breasted Water-Rail. Hypotænidia striata gularis.**

A rare bird, I should say, in the actual hills Chin and Kachin which provide no suitable marshy grounds for them; but in the Shan Hills where numerous swampy areas occur they are to be found and breed.

647. **The Eastern Baillon's Crake. Porzana pusilla pusilla.**

I have never came across this bird in the hills but remember getting a specimen in the Andamans; they winter, I daresay, in the Shan Hills.

648. **The Banded Crake. Rallina superciliaris superciliaris.**

My dog caught a specimen on the Taunggyi crags, South Shan Hills, evidently migrating, judging by its weak state and I saw another specimen which also could hardly fly. Next year on practically the same date I saw another bird of this species very near the same spot; this was early in May. This bird flew up into a tree and perched on a branch quite close to me.

649. **The Malayan Banded Crake. Rallina fasciata.**

I do not know if this bird has been recorded in the Burmese Hills. I found its nest near the South Chin Hills. It also undoubtedly migrates locally.

650. **The Northern Ruddy Crake. Amaurornis fuscus bakeri.**

A bird of the Chin Hills; the Kachin Hills subspecies is intermediate between this and the next subspecies.

651. The Chinese Ruddy Crake. Amaurornis fuscus erythrothorax.

The Shan Hills variety; it breeds in suitable places and my eggs taken at Maymyo, Shan Hills average about 29 × 23 m.m.; so it does not seem the size of the eggs quoted in the new edition of the *Fauna* is abnormally small as stated.

652. The Chinese White-breasted Water-Hen. Amaurornis phœnicurus phœnicurus.

All these hills. In the Shan Hills it loves the jungle edged stream irrigating small areas of paddy land—a very noisy bird often calling at night. It has the unusual habit for rails of climbing up or flying into trees often quite 30 ft. up and is certainly less of a skulker than the crakes. The young are covered with black down.

653. Elwes's Crake. Amaurornis bicolor.

I never came across this bird myself in the Shan Hills but knew it well in the Chin Hills where it frequents the small hill side streams amongst grass and cultivation where it is common. It probably occurs also in the Kachin Hills in similar places.

654. The Indian Moorhen. Gallinula chloropus indicus.

Not so common as one would imagine and I don't think I ever saw a specimen in the Chin Hills although occurring in the valley bordering these hills, the reason for this being that suitable places are not available.

In the Shan Hills the moor-hen occurs in all decent sized lakes or tanks in the winter months but does not always breed where they are found; seeking in the rains (July) the largest tanks well covered with weeds, bushes, etc, for this purpose.

655. The Kora or Water-Cock. Gallicrex cinerea.

Requires large areas of paddy land and grass round the bigger lakes as a habitat. In the Shan Hills it was especially common round the big lake below Taunggyi (Fort Stedman).

Said to be very destructive to young rice by eating the shoots and are also very good for the table.

656. The Indian Purple Moorhen. Porphyrio poliocephalus poliocephalus.

Burmese name Maynyo.

Also common where the water cock is found but seems to haunt the lake itself in parts where weeds and lilies abound. It is found also on a good many tanks where there are no watercock.

657. The Coot. Fulica atra atra.

Noticed on a big inland lake near the Lushai Hill border, Chin Hills, where I expect it may breed; not seen in the Shan Hills.

LIV.—Family Heliornithidæ.

658. The Masked Finfoot. Heliopais personata.

I once saw this bird on one of the largest streams in the Shan Hills otherwise it does not seem to be recorded: it must be very rare.

LV.—Family Jaçanidæ.

659. The Bronze-winged Jaçana. Metopidius indicus.

Common on any of the bigger stretches of water. I never saw it in the Chin Hills proper.

660. The Pheasant-tailed Jaçana. Hydrophasianus chirurgus.

As for the preceding species.

LVI.—Family Rostratulidæ.

661. The Painted Snipe. Rostratula benghalensis benghalensis.

Here again is a bird which prefers the plains to the hills but it is found in the Shan Hills 3,000 ft. in suitable places, i.e., swamps where it breeds.

Seems to commence breeding in June and goes on well after the real snipe are in—a female shot at the end of September was laying—an unsatisfactory bird both for sport and table.

LVI.—Family Gruidæ.

662. **The Hooded Crane. Grus monachus.**

Recorded from the Kachin country probably on the Irrawaddy River.

663. **The Burmese Sarus Crane. Antigone antigone sharpei.**

Chin, Kachin and Shan Hills: in the latter area quite a common crane: about the end of August for eggs.

664. **The Demoiselle Crane. Anthropoides virgo.**

This is, I think, a rare bird in Burma and especially the Burma Hills, but flocks are met with on the Shweli River on the Chinese boundary, N. East Shan Hills and I saw them at Namhkam, a place on this river where Harington records *Grus grus lilfordi*, the Eastern Common Crane.

LVIII.—Family Œdicnemidæ.

665. **The Great Stone-Plover. Esacus recurvirostris.**

Only in Kachin country along the Irrawaddy River sand-banks.

LIX.—Family Glareolidæ.

666. **The Large Indian Pratincole or Swallow-Plover. Glareola maldivarum maldivarum.**

The Shan Hills are the only hills where I have met with this bird. Found nesting chiefly round tanks on dried up swamps and paddy fields, the dry grass on which has often been burnt before nesting takes place.

I agree, as the *Fauna* says, it must be locally migratory and, as also stated, the efforts of this species and the next to deceive one in thinking they are wounded and thus lure you away from the nest are quite the best efforts of any bird I have ever seen behave in this way.

The eggs are very handsome miniature plovers, eggs laid about the middle of April.

667. **The Small Indian Pratincole or Sand-Plover. Glareola lactea.**

Breeds on sand-banks of the Irrawaddy River and may thus be found in Kachin country. I have not noticed it in the Shan or Chin Hills but it might occur on the Shweli River ? on the Chinese boundary.

In Burma I have never found more than 2 eggs in the clutch.

LX.—Family Laridæ.

668. **The Black-headed Gull. Larus ridibundus.**

Probably the gull I have seen on the Inle lake below Taunggyi. Southern Shan Hills in the winter.

LXI.—Family Sternidæ.

669. **The Indian River-Tern. Sterna aurantia.**

Not in the Chin Hills and probably only in the river part of the Kachin Hills. I have seen it on the big lake of the Shan Hills, but it does not breed.

670. **The Black-bellied Tern. Sterna melanogaster.**

Harington records this tern on the Irrawaddy River, Kachin country, but I have no note of its occurrence in the Shan or Chin Hills.

671. **The River-Ternlet. Sterna Albifrons pusilla.**

The Ternlet recorded by Harington as occurring at Bhamo, Kachin country, was probably this one.

LXII.—RHYNCOPIDÆ.

672. **The Indian Skimmer. Rhyncops albicollis.**

Recorded by Harington in the Irrawaddy River, Kachin country. No record of it elsewhere and it is not likely to occur.

LXIII.—Family CHARADRIIDÆ.

673. **Jerdon's Little Ringed Plover. Charadrius dubius jerdoni.**

I include this as being the bird I noted on some of the larger rivers of the Shan Hills. One April I searched for its nest for a long time in the shingle bed of a river about 1,500 ft. elevation, a tributary of the Namtu River, where it was obviously breeding but without success and so I never shot the bird—Young?

They have a distinct alarm cry.

674. **The Eastern Golden Plover. Pluvialis dominicus fulvus.**

A winter migrant to the open grassy plain parts of the Shan and Kachin Hills. I never heard of one being shot in the Chin Hills.

675. **The Lapwing or Green Plover. Vanellus vulgaris.**

Recorded by Captain Hanna, I. A. from Fort Hertz, the most northerly outpost of the Kachin Hills—a winter visitor. Vol. xxxii, p. 220 of the *Journal*.

676. **The Spur-wing Plover. Hoplopterus ventralis.**

Only on the plains at the foot of our hills Chin and Kachin, but in the Shan Hills the larger rivers being more to its liking they live and bred where found—Middle of March for the nests.

677. **The Burmese Red-wattled Lapwing. Lobivanellus indicus atronuchalis.**

Breeds and inhabits any open spaces in the Shan Hills but a river or water is generally if not always handy. It must occur round Bhamo and other plains places in the Kachin Hills, and in these hills too in suitable places.

678. **The Grey-headed Lapwing. Microsarcops cinereus.**

Small parties of this bird are occasionally met with in the Shan and Kachin Hills. In the former I shot one at Maymyo North Shan Hills where a small party of about a dozen individuals turned up regularly in the winter and lived near the golf-course, disappearing in April and never breeding.

LXIV.—Family SCOLOPACIDÆ.

Except the snipes few of the family inhabit these hills but the following may be found in the Shan Hills especially, as winter visitors.

679. **The Whimbrel. Numenius phæopus phæopus.**

680. **The Wood-Sandpiper. Tringa glareola.**

681. **The Green Sandpiper. Tringa ochropus.**

682. **The Common Sandpiper. Tringa hypoleucus.**

683. **The Redshank. Tringa totanus totanus.**

684. **The Woodcock. Scolopax rusticola rusticola.**

Although, I think, it may be asserted the Woodcock does not breed in Burma, the bird is to be found in the Chin, Kachin and Shan Hills during the winter months October to April in places which suit it. The Woodcock likes small swamps, with bushes about, through which there is running water.

They often appear to spend the day away from their feeding grounds to which they flight just at dusk.

685. **The Wood-Snipe. Capella nemoricola.**

A rare bird apparently in the Chin and Kachin Hills but in the Shan Hills in some places it is quite common. I do not know where Captain Livesey made his bag of twenty, but I can quite believe it. Near Taunggyi in one particular

swampy hill side there were always a number of them in the cold weather. They are not very sporting shots and certainly inferior to the Fantail for the table.

686. **The Eastern Solitary Snipe. Capella solitaria.**

I have skinned one, shot in the Chin Hills and seen a skin from the Shan Hills, but they are rare.

687. **The Common or Fantail Snipe. Capella gallinago gallinago.**

To be found in all these hills in suitable places ; perhaps more common in the Shan Hills as more suitable ground is available.

In these latter hills they begin to arrive about the 20th August. At first not so numerous as the next species but later on bags contain about equal numbers generally speaking ; sometimes however bags may be all the next species and sometimes all Fantail, a great deal depending on the ground shot over. Fantails prefer open 'Kwins' (fields), the wetter the better, while Pintails can do with much less wet ground.

On first arrival the Fantail is often in 'wisps', is wild and certainly always the more difficult to shoot. Again the Fantail is considered the best snipe for the table.

688. **The Pintail Snipe. Capella stenura.**

As above the Pintail is however occasionally to be found in quite dry fields. Why ? I could never make out ; perhaps they were not feeding or again some sort of worm was available on the surface that one did not notice. At the end of the season, the Pintail is often shot in April, they fall off considerably as a table delicacy.

689. **The Jack Snipe. Lymnocryptes minima.**

I don't remember one being shot in the Chin Hills, but they probably occur in the Kachin Hills. In the Shan Hills, however, I have obtained them although there are never many about.

LXV.—Family PHALACROCORACIDÆ.

690. **The Little Cormorant. Phalacrocorax niger.**

The only species of this family seen in the Shan Hills on lakes where other water birds occur.

LXVI.—Family IBIDIDÆ.

691. **The Glossy Ibis. Plegades falcinellus falcinellus.**

I can find no record of this bird in the Chin Hills or any ibis for that matter but it probably occurs in the Kachin country, near Bhamo and I shot a young bird in the Shan Hills at a place where there was quite a decent flock of them in the winter.

LXVII.—Family CICONIDÆ.

692. **The White-necked Stork. Dissoura episcopa episcopa.**

693. **The Black-necked Stork. Xenorynchus asiaticus asiaticus.**

Recorded from the Kachin country, but I have no record of their occurrence elsewhere in these hills, but they probably occur on suitable plans.

LXVIII.—Family ARDEIDÆ.

The following herons and bitterns occur in these hills but are not naturally hill birds and if it wasn't for the upper waters of the Irrawaddy River being included and some large lakes like the Inle lake below Taunggyi members of the family would be very few.

694. **The Eastern Purple Heron. Ardea purpurea manillensis.**

695. **The Eastern grey Heron. Ardea cinerea rectirostris.**

696. **The Eastern Large Egret. Egretta alba.**

697. **The Indian Smaller Egret. Egretta intermedia intermedia.**

698. **The Little Egrat. Egretta garzetta garzetta.**

699. **The Cattle Egret. Bubulcus ibis coromandus**

700. **The Indian Pond Heron. Ardeola grayii.**

701. **The Indian Little Green Bittern. Buturoides stiratus javanicus.**

702. **The Night Heron. Nycticorax nycticorax nycticorax.**

703. **The Chestnut Bittern. Ixobrychus cinnamomeus.**

LXIX.—Family Anatidæ.

The following ducks are to be found in the hills in suitable places and times.

704. **The Nukta or Comb-Duck. Sarkidiornis melanotus** (breeds).

705. **The White-winged Wood-Duck. Asarcornis scutulatus** (breeds).

706. **The Cotton Teal. Nettapus coromandelianus** (breeds).

707. **The Grey Lag Goose. Anser anser.**

708. **The Bar-headed Goose. Anser indicus.**

709. **The Common Whistling-Teal. Dendrocygna Javanica** (breeds).

710. **The Larger Whistling-Teal. Dendrocygna fulva.**

711. **The Sheldrake. Tadorna tadorna.**

712. **The Ruddy Sheldrake. Casarca ferruginea.**

713. **The Mallard. Anas platyryncha.**

714. **The Eastern Grey Duck. Anas pœciloryncha zonoryncha.**

715. **The Burmese Grey Duck. Anas pœciloryncha haringtoni.**
The most common duck of the hills (breeds).

716. **The Wigeon. Maeca penelope.**

717. **The Pintail. Dafila acuta acuta.**

718. **The Garganey or Blue-winged Teal. Querquedula querquedula.**

719. **The Shoveller. Spatula clypeata.**

720. **The Eastern White-Eye. Nyroca rufa baeri.**

LXX.—Family Podicepidæ.

721. **The Great Crested Grebe. Podiceps cristatus cristatus.**
Rare visitant Chin and Kachin Hills.

722. **The Indian Little Grebe. Podiceps ruficollis capensis** (breeds).

THE PANTHER AS I HAVE KNOWN HIM.

BY

LT.-COL. A. H. E. MOSSE, I.A., F.Z.S.

PARTS I AND II.

(With two plates.)

I. GENERAL.

Whether he be called the Panther, as is usually the case in India, or the Leopard, the name by which he is generally known elsewhere, my subject is a beautiful and interesting animal who deserves a higher place on the Register of Big Game than he is sometimes accorded.

This is largely because he is overshadowed, in India by the Tiger, in Africa by the Lion. There are, however, various districts, especially in Western India, where tigers either do not exist or are few and far between, but where panthers are common enough. In such areas it is sometimes possible for the District Officer, when he can spare the time and will take the trouble, to cultivate the acquaintance of the panther in the ordinary course of his district touring and on occasional short holidays. To obtain any substantial success with tiger he would have to make a regular expedition farther afield—only possible during periods of leave which the married man, at any rate, cannot often afford to spend on shikar.

In such circumstances one may learn to know the panther better than many another man who has slain his tigers by the score but has neglected the smaller beast. During periods of my service in the Political Department I have been so situated and venture to think that an account in some detail of the panther as I have known him, as also of methods of dealing with him, may be of interest and of some assistance to those who may have the opportunity and desire of making his closer acquaintance.

My experiences have been mainly in the northern part of the province of Gujarat in the Bombay Presidency, a country whose cultivated plains are bounded by a system of low jungle-clad or rocky hills increasing in height up to the borders of Rajputana. In the Mahi Kantha Agency, situated in the western portion of this area, many of these hills are covered with great boulders and, as will be seen, offer better opportunities of actually observing the panther than does country that is all under jungle.

Fine specimens of *Felis pardus* or *Panthera pardus*, as he is now called, are occasionally shot in North Gujarat and Kathiawar but, as a rule, the size attained in this part of India is, on the average, rather less than that of the large animal to be found in heavy forest country elsewhere. On the other hand the definitely small type, with very round head, which some sportsmen have sought to distinguish

as a distinct species, is not found, except in immature specimens whose occipital ridge is undeveloped. This small type, which has been labelled 'leopard' as distinct from the larger 'panther,' does not ever, I believe, attain six feet in length, whereas I have never seen an adult male in Guzarat which did not substantially exceed this measurement.

Among some fifty panthers that I have personally measured, the length of an adult male in North Gujarat and Kathiawar has varied from six feet four to seven feet four and a half inches, with tails varying from twenty-six to thirty-four inches. My largest female was six feet four but I have seen one or two that were certainly larger. The largest males killed in these parts, of whose authentic measurements I am aware—though I have heard stories of larger ones—were two, both of seven feet eight, shot by that well-known shikari the late Lt.-Col. L. L. Fenton, one in the Danta State and one in the Gir Forest in Kathiawar.

It must be emphasized that all these are 'straight' measurements between pegs. Both of Colonel Fenton's large panthers would have been eight-footers if measured along the curves of head, neck and back. Measurement along the curves, if taken with care, would mean an increase in length of from two to four inches. If taken carelessly, however, the difference may easily be as much as six or seven inches in a large male. An interesting correspondence in the *Field* not long ago, culminating in an excellent article by Mr. Dunbar Brander, proved conclusively—if proof were necessary—the unsatisfactory character of 'curve' measurements. The only sound method is to lay the animal on its back, press the chin to the ground and measure between pegs placed at the tip of the nose and at the root and the tip of the tail. I am whole-heartedly at one with the writer above mentioned in his efforts to educate a section of the shooting public upon this subject. It is no question of theory but of practical commonsense based upon experience.

The weight of a good male panther in Gujarat is something over 100 pounds. I have records of two only: one in Danta, measuring 6 feet 10½ inches weighed 114 pounds, ten hours after death: the second, a Kathiawar panther 7 feet 1 inch in length, weighed 123 pounds about eight hours after death. Both were in good condition.

With regard to coat and colouration, it may be observed that the fur is longer and the general effect somewhat greyer and darker in an immature specimen. Also that the ground colour as a rule tends to become paler in an old beast. Otherwise I have found no great differences in colouring or pattern among panthers of North Gujarat and Kathiawar apart from some variation in the size and boldness of the rosette markings.

I have no evidence of the period of gestation; it is said to be about three months. There does not seem to be any particular season for mating. I have come across a mating pair more than once in the month of May and in the same month have killed a female with young in the foetal stage an inch long and seen cubs of ages from two to six months. I have not personally seen more than two cubs running with the mother but believe three is not an

uncommon number, while the female above mentioned contained four young.

I do not intend to hold forth on the choice of weapons generally; enough to warn the novice against the use of too light a bullet. The modern *magnum* small-bore, with a muzzle velocity of 3,000 f.s. or so, is a wonderful killing weapon, *in the hands of an expert shot.* It is, however, open to the objection that, in order to obtain the necessary expansion, the light bullet is necessarily rather fragile in make, with the consequent risk of its going to pieces without penetrating, should it strike a big bone. I know of more than one experienced shikari who habitually used these weapons for a time against tiger but has now given them up in favour of a larger bore with less extreme velocity. Any medium bore rifle with an expanding bullet is good enough for panther; the ·318 with 250 grain bullet—copper capped in preference to soft nose—takes a lot of beating. Provided that the weight is not excessive a double-barrel is preferable to a magazine rifle for jungle work. A 12-bore shot gun with 'Lethal' bullet is effective at close range. If you prefer to use buckshot at night, the powder-charge, if your gun will stand it, should not be less than the equivalent of 3½ drams black powder, and the maximum range twenty yards: it is advisable to test beforehand the pattern which your gun makes with a buckshot charge, and I recommend *SSSG* as containing a larger number of pellets to the charge than *SSG.*

An advantage of the 12-bore at short range lies in the handiness of the weapon which you are accustomed to use on feathered game. This fact, together with its heavy bullet and increased range as compared to the ordinary smooth-bore, makes a good shot-and-ball gun, an excellent weapon for soft-skinned dangerous game. I have killed the majority of my panthers, besides several lion and tiger, with a 12-bore *magnum* 'Paradox', a gun which I have more than once used effectively on a Nilghai bull at 150 yards, though I do not recommend its use on dangerous game beyond 100 yards range.

Accuracy, of course, is of prime importance. The first shot is the one that counts. It is a well-recognized fact, to which every experienced sportsman will testify, that a wounded animal takes much more killing than an unwounded one. Whatever the physiological reason, the shock of a wound not immediately fatal seems to stimulate the nervous system and cause a temporary increase of vitality.

It follows that it is most desirable to know where to hit an animal. Both the brain and neck shot are deadly if accurately placed, but are risky unless you are absolutely sure of them. I have spanned with my fingers the horns of an apparently dead blackbuck and then seen it rise and depart as if unhurt. A shot in the neck had grazed the spinal cord and caused a merely temporary concussion. Later on I hope to give one or two examples illustrating the uncertainty of the head shot.

As a rule the best place to try for is the area containing the heart and lungs. But you must learn to judge the correct angle according to the position of the animal: wherefore it is necessary to have some idea of a beast's anatomy. If broadside on, aim at the point of

the shoulder or immediately behind it rather more than half way down. But if an animal is facing obliquely away from you the actual point of aim must be farther from the shoulder along the body.

In jungle country one may occasionally have the luck of a casual meeting with a panther but, speaking generally, there are two methods of bringing a panther to the gun—'beating' and 'sitting up'. So much has been written by competent authorities on the theory and practice of beating for tiger that I do not propose to say much on the subject. The principles in beating for panther are the same, with these differences that, in the case of the smaller animal, such extensive areas cannot be beaten as in the case of the larger, nor is it of any use trying to beat a panther out of really thick jungle. A panther, moreover, especially a small one, will sometimes seek refuge in a tree and lie close while the beaters pass below him. A large panther is easier to beat than a small one but is not likely to travel as far when disturbed as a tiger. Provided these considerations are borne in mind, it is quite a mistake to suppose, as some do, that beating for a panther is always too uncertain to be worth while: in suitable conditions it can be done, as I have often proved. A point to which it is important to pay special attention is the placing of stops, a fact which many Indian shikaris fail to understand.

Apart from its being within reach of the spring of an enraged beast, too low a *machán* is a mistake owing to the greater risk of its occupant catching the eye of his quick-sighted quarry. At the same time it is essential to have freedom of movement and as clear a field of view and fire as possible. It is therefore out of the question to try and conceal oneself as one can and must do when sitting up over a bait or 'kill'. Concealment during a beat is the less necessary because, quick though the panther is to detect the least movement, it is remarkable how incapable he appears to be of identifying a motionless object. I have seen a panther, in a beat, come suddenly round a corner, catch sight of the *machán* on which I was sitting only twenty yards away and fully exposed, and stare straight at me for about ten seconds, then move quietly on, treating me as of no further interest. Other animals have this negative characteristic. I have known a sambar hind graze leisurely up to within fifteen yards of me as I sat with two shikaris on an open hillside. Then it became suspicious, but being to windward of us and detecting no human taint, still did no more than stare and stamp with its forefoot half-a-dozen times to try and make the doubtful objects, if alive, declare themselves. With great wide-open eyes she made a delightful picture. It was only when one of my men could contain himself no longer and sprang to his feet with a yell, that she fled, with the shock of her life. Provided, therefore, that you keep still and, if an animal stares at you, do not let its eyes meet yours, you are not likely to be detected. Failure to keep still may often lose you a chance. I have known a panther spot a movement in my *machán* at a distance of 400 yards.

The beat is generally a noisy affair with much shouting and beating of tomtoms, but in a small beat quieter methods are often

better. During the period of waiting there is often much of interest to occupy one's attention in the various creatures that make their appearance, from deer and wild boar to jungle-fowl or a resplendent peacock. And, as the beaters approach, a troop of keen-eyed monkeys will perhaps give warning that their most hated foe is on the move. The blood tingles in your veins and your grip tightens on your rifle as you strain your eyes into the cover to try and distinguish that coat of brilliantly contrasting black and tawny-yellow whose hues yet blend in such amazing fashion with the light and shade of the jungle so as often, if motionless, to be quite indistinguishable twenty yards away. I suppose I have seen a hundred panthers in their native wilds, yet their wonderful gift of invisibility remains as great a marvel as ever.

Your panther may not appear at all. He has perhaps stolen away unobserved, between the very feet of the beaters or past an inattentive stop—or past you yourself as you looked in the wrong direction. But if he comes it will probably be sneaking stealthily along wherever there is any cover, breaking into a trot or gallop to cross an open space, or stopping every now and then to reconnoitre his front or listen to the uproar behind.

When at last your opportunity comes, do not be in a hurry, take no long shots, and generally, if possible, let the beast pass you a little way before firing. This last should be a hard and fast rule for the inexperienced sportsman. The reason for it lies in consideration for the safety of your beaters. For you may only wound the panther; in which case, if hit from behind or from the side while advancing, he will probably dash forward. But if he realizes that his enemy is in front the chances are that he will break back; and, if he finds his path barred, someone or more than one person will suffer; for, if earth holds no fury like a woman scorned, a wounded pard is a good second! His capacity for concealment—he can almost hide himself behind a few blades of grass—his courage and ferocity when enraged, the noiselessness of his movements, and the lightning-like agility of his attack with fang and claw, combine to make a wounded panther one of the most dangerous of beasts. If to these qualities were added the weight and strength of the tiger no other animal could compare with him. In breaking through a line of beaters, where the tiger may kill one man the panther will maul half a dozen, using his claws to a much greater extent: and it is in the poisonous character of these claw-wounds that the danger lies.

If you wound a beast in daylight, give him an hour in which to die or get stiff. Then follow his tracks. It is here that a big bullet may prove its value in providing a good blood trail. For the best methods of following up, study what Colonel A. E. Stewart has to say on the subject in his excellent book *Tiger and other Game.* His advice on the subject of beats, by the way, is also A.1. Following up a wounded carnivore is a strain on the nerves, but you *must* keep on the alert and never let your attention slacken. The most important points are to go slow, send men up into every tree as you approach it to see if they can detect anything, and test every bit of cover with stones before you reach or pass it. It is almost

incredible how a panther will conceal himself in cover that you imagine would scarcely hold a hare.

Especially when following up must you bear in mind that not only your own safety but the lives of your unarmed trackers may depend upon your alertness, judgment and straight shooting. For the weapon in your hand at the time nothing is better than a good 12-bore ball-and-shot gun.

Before going on to deal with the second method of bringing a panther to bag, that of 'sitting-up', it will be convenient to set down here some remarks on the character of the panther. Writers on big game have not always done him justice. Granted that, alongside the magnificent tiger, he is comparatively small beer; yet see him in an open glade in his native jungle, observe the muscular but agile symmetry of his form and the beauty of his chequered coat in the rays of a declining sun; he deserves more than a second glance. Granted too, perhaps, that you may fairly, as one writer has done, describe the tiger as a gentleman, the panther as a bounder—though I question whether the difference in their respective characters is really such as to justify the distinction—but to say, with the same writer, that 'the panther is what he looks, a perfect swine' is a libel, that is, in the sense in which the term is used. For, come to think of it, it seems rather ridiculous that any sportsman who has really known that splendid beast, the fighting boar of India, should use the word swine of any animal as a term of contempt! To call the panther an arrant coward, as another writer has done, may be merely an instance of the folly of generalizing from a single case. No tiger hunter of experience will deny that the tiger himself can sometimes be a cur. Otherwise, to use the above-mentioned writer's own adjective, to label the panther a coward is arrant nonsense. The courage of the normal panther cannot be gainsaid.

Of course, the panther, like any other wild animal, will seek to escape unobserved from the pursuit of men, whose superior powers he recognizes. Does not the tiger do the same? But wound him or get him in a corner and he is as ready to fight, and fight to some purpose, as is the tiger; perhaps more so. All said and done it is but his greater size that makes the tiger more to be feared. The panther displays at times a cool daring that the tiger will rarely rival. Make no mistake about it, he is a formidable foe and, if you begin by despising him, sooner or later he will give you cause to change your opinion and earn your respect. If you once grant him a title to respect you cannot call him a swine, much less a coward which he certainly is not.

In districts where they are common, panthers do much damage both to stock and to game, and no dog is safe in panther country. It may, therefore, be justifiable to write them down as vermin. Yet . . . here let me tell a tale of a panther mother. I was once on the march between two camps. The bullock carts conveying my tents and baggage, etc., had gone ahead but had been delayed through getting stuck in a sandy river-bed, and I overtook them at a place where the road, or rather cart-track, passed for a mile or so through a patch of jungle. It was about 10 a.m. and I was

riding leisurely along some twenty yards behind the rearmost cart on which was travelling a terrier who then owned me, with her family of three children about two months old. The cart was bumping along a track that was decidedly rough at this spot, and met a bigger bump than usual just as one of the pups had scrambled upon to a roll of tentage at the rear of the cart. The little chap lurched forward and fell to the ground yelping. He seemed hardly to have touched the ground, poor little beastie, when a yellowish streak flashed out from some bushes at the roadside and, before one could lift a hand, panther and victim had vanished.

That was not the end. As soon as I realized what had happened I turned and shouted to the sowar behind who was carrying my rifle. Then, looking round again, I was amazed to see the panther race back across the track between me and the cart, the pup still in her jaws, and regain the bushes from which she had just emerged. Why? There was no lack of cover on the other side. Investigation found the explanation in clear signs of the presence of a pair of cubs perhaps three months old—a family for whose feeding risks must be taken, but who were not to be left alone in the vicinity of danger. I sought vengeance for the poor wee pup, though without success. But I could not withhold my meed of admiration for the combination of patient watching for and amazingly prompt seizure of an opportunity, the audacity of the successful rush, and the maternal devotion which took the risk a second time after the alarm was raised. Highway robber and dangerous vermin, perhaps, but a gallant beast to whom, mentally, I took off my hat. Would a tigress have dared that deed? . . .

Generally speaking it may be laid down as an axiom that neither tiger nor panther will ever, unprovoked, attack mankind. It is the Jungle Law, by virtue of the respect for and dread of man in which all the Jungle creatures are brought up. But when a panther takes to man-eating—fortunately not a very common occurrence—he is in some respects more dangerous than a tiger. He is definitely more audacious and will take greater risks. This is partly a matter of inherent character but also in part due to the fact that, from his habit of prowling round villages in search of stray dogs, etc., he has grown more familiar with mankind than is the tiger, with the result that he will not infrequently enter a hut in search of a victim, a thing the tiger will very rarely do. I have personally known half-a-dozen cases of people being dragged from their own huts at night by panthers who had been driven to man-eating by the effects, on game and cattle, of the famine conditions which prevailed in Gujarat after the great drought at the beginning of the present century.

So much for the character of my subject. In the next part of this article I propose to discuss in some detail the theory and practice of circumventing him by 'sitting up'.

II. The Art of Sitting Up—Its Theory and Practice.

By most Indian sportsmen the above heading will at once be understood. There may be others who will need the explanation

that my subject is the method of shooting tiger and panther or leopard in India by 'sitting up' for the quarry in ambush over either a 'kill' or a live bait. To the stay-at-home reader the subject of tiger-shooting usually conjures up a vision of hunting him with a line of trained elephants in the high grass of the Nepal Terai, or else of driving him past the gun with a horde of yelling beaters in the jungles of the Central Provinces. There are, however, places and circumstances in which neither of these methods is practicable and a good many tigers are killed in India by the silent and less spectacular method of sitting up. The majority of panthers shot are killed in this way. But, while much has been written about beating for tiger, the matter of sitting up is often passed over in a few words. An exposition, therefore, in some detail, of this form of sport, followed by an account of some illustrative incidents of personal experience may be of use to the novice who wishes to try his hand and of some interest to others.

To begin with, to those who really know anything about the game no defence will seem necessary. But not long ago I read, in a review of a work on big game, an unmeasured condemnation of the practice of sitting up. The critic in question had no fault to find with the method of driving a tiger past a gun, but sitting up over a 'kill' or bait he considered in the last degree unsporting. A brief consideration of the ethics of the matter may, therefore, not be out of place.

The argument against sitting up is based on the view—with which, thus stated, one may cordially agree—that the odds are so greatly in favour of the man armed with a modern rifle that he is not justified in killing big game unless he obtains his opportunity by pitting his skill and intelligence against the cunning and instincts of the wild animal and by outwitting it under conditions in which the animal has a fair chance of evading the hunter and, preferably, of making use of its own weapons of offence and defence if it possesses them. The argument assumes that there can be no scope for any real exercise of skill or intelligence in shooting at close quarters, from safe ambush, a beast which has no chance of escape or of retaliation and that the method merely takes a mean advantage of the unfortunate creature's need for food.

Plausible, but unsound. Though even were there no flaw in the argument, I do not consider the principles of pure sportsmanship really enter into the matter when the panther or leopard is in question. These animals, from the point of view of the cattle owner and shepherd, and of every dog lover, are vermin which do a great deal of damage and their numbers in many places require to be kept down, while, apart from trapping or poisoning, sitting up is often the only possible method of dealing with them.

To return to the argument of our critic. The fallacy lies in the assumption to which I have referred, an assumption which I propose to show is entirely unjustified and based on ignorance of what sitting up involves. Undoubtedly the most sporting method of shooting dangerous game is to track it down on foot. I have had the good fortune to shoot lions in Somaliland at close quarters in this manner and to experience the thrills that such a method can

provide. But unfortunately it is rarely that tiger or panther can be so approached under Indian conditions—except by a very occasional stroke of sheer luck. In North Gujarat, the part of India of which I have most experience, elephants are not to be had and there are usually only two alternatives, beating or sitting up. To the practice of beating, as I have already remarked, the critic to whom I refer had no objection; but let us consider what happens in a beat. The tiger or panther is roused from its siesta by a human uproar from which it naturally seeks to escape in the direction of the nearest hiding place it knows, in a direction from which comes no sound of danger. Except in the case of an occasional old and experienced beast it is not then, as a rule, on the lookout for enemies in the trees in front, for its main idea is escape from those behind, and it passes unsuspecting by the *machán* whence the unseen hunter fires the fatal shot.

In what way can this honestly be described as more 'sporting' than sitting up over a 'kill' which, nineteen times out of twenty, a tiger or panther approaches with the utmost circumspection? In either case you shoot from ambush. True, in a beat, you may have to take a galloping or longer and, in the sense of being more difficult, a more sporting shot. But that means that you run a much greater risk of inflicting a non-vital and non-disabling wound—a result surely, which it must ever be the real sportsman's object to avoid! Even if your aim be true and you inflict a vital, but not immediately fatal wound, you at once endanger the lives of your unarmed beaters: no such risk attends sitting up. Personal risk to yourself, as a rule, enters into the matter only when you have to follow up a wounded beast; then come the real thrills. This may happen as a result of sitting up though, perhaps, less often than after a beat. But, however keen you may be on thrills, your primary object must be to kill and not to wound. How then can sitting up be condemned as unsporting on the ground that it usually affords—if you get a chance at all—a reasonably certain shot at close range?

I do not mean to imply that one never misses or wounds when sitting up, even in broad daylight. A little unnecessary hurry, excitement or lack of concentration may result in the most amazing failures: there is, in fact, plenty of scope for care and judgment in choosing the right moment to shoot and the right spot at which to aim. Of course, too, there is no certainty about shots taken in the dark or in a bad light, but these are definitely unsporting and you must make up your mind that you will not indulge in such; the surest way is not to expose yourself to temptation and to leave your *machán* when sights or target are no longer sufficiently visible.

There are, however, various devices for dealing with bad light, which I shall discuss later. It must, however, be clearly understood that in advocating sitting up I assume the use of weapons of adequate power. Sitting up with the mistaken idea that, because the range is short, otherwise inferior weapons will be effective, is a practice to be unreservedly condemned.

Another of our critic's arguments is that it is not playing the game to take a mean advantage of an animal's need for food. Is

not this exactly what one does when one lies in wait for the evening flight of duck on their way to their nightly feeding places? Is there any logical difference? Sitting up over water in the hot weather when there is only one drinking place in the neighbourhood is a different matter. No true sportsman will do this unless a man-eater be in question; then there can be no scruple. In such circumstances the pangs of thirst produce a compulsion to visit the only watering place which is not comparable to the inducements of hunger in respect of a particular kill. The great *carnivora* can do without food for many days but drink they must have; while, if the proximity of the previous night's kill is suspect, a fresh meal can be sought elsewhere and, more often than not, this is actually what happens.

A further fallacy of the hostile criticism is the assumption that in sitting up no intelligence or skill is required to insure the desired response, on the part of the quarry, to the invitation to come and be killed. I hope to show by examples, from personal experience, how the suspicious nature, the eternal watchfulness and the quickness of sight and hearing of the great cats make of sitting up a real art. It is an art of which the essential elements can only be learned by a knowledge of the habits of one's quarry and of the precautions which those habits render necessary—a knowledge which can only be acquired by the application of intelligence in learning from the lessons of failure. If you do not take all these precautions you may, if you are fortunate, achieve some small measure of success, but you will not deserve it and you will certainly have a far larger percentage of failures than if you had taken them.

Colonel Stockley in his interesting book on 'Big Game Shooting in India, Burma and Somaliland,' cites a mighty tiger hunter—Sir Montague Gerard—as recording that, as a result of sitting up two hundred times for tiger, 'taking all the usual precautions', he only succeeded in killing one and wounding another! This should satisfy the doubter that it is not quite such a simple game as might be imagined: but there must have been something radically wrong with the famous sportsman's methods!

Personally, when sitting up for panther, the difference to my success, since I have known what to do and what not to do, has been most marked. In my early days I was stationed for two and a half years in a district where panthers were common. During that period I bagged a number in beats but, as a result of sitting up about forty times, I never once saw a panther in daylight and on three occasions only had a shot at one after dark. Twenty years later, in the same district, I found that my panther gave me a shot on an average of rather better than one evening out of four and, in the great majority of cases, either in broad daylight or while it was still light enough to see my foresight clearly. It was not that the panthers of the later generation were more numerous or less sophisticated than their forbears, but that I had learned from the lessons of failure. General Wardrop—*vide* his *Days and Nights with Indian Big Game*—has had a very similar experience. These are facts which speak for themselves.

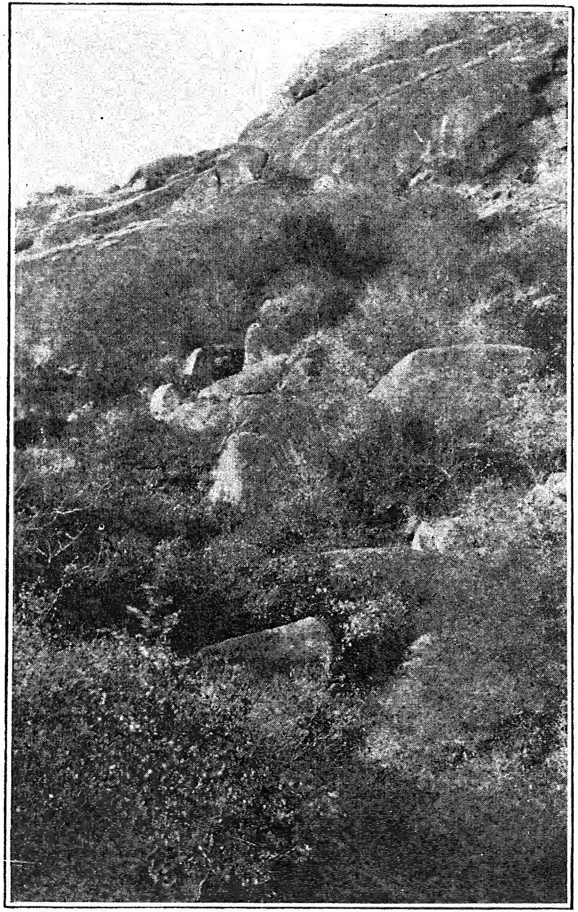
There may be something repugnant in the idea of sitting over a live goat and watching the unfortunate creature done to death;

but after all it makes no difference to the goat whether it meets its fate under a human eye or not, and the practice is universal in India of tying up a live bait in order to obtain a kill, whether with the object of sitting over the latter the following day or of beating the tiger out of the adjacent cover in which it lies up after its meal. Moreover, when you sit yourself over a live goat, the latter has a greater chance for its life than in the former case, since it should be your object, if opportunity occurs, to shoot the panther before it seizes its prey and, in practice, it is often possible so to save the life of the goat: in such event it is but fair to grant the individual goat immunity from having to run the risk a second time. It is quite a mistake to suppose that the goat has any anticipation of its possible fate, while death, if it does come, is speedy and, be it borne in mind, the sacrifice of one goat and the resultant death of its slayer means the saving alive of many, for the depredations of panthers on the village herds are continual.

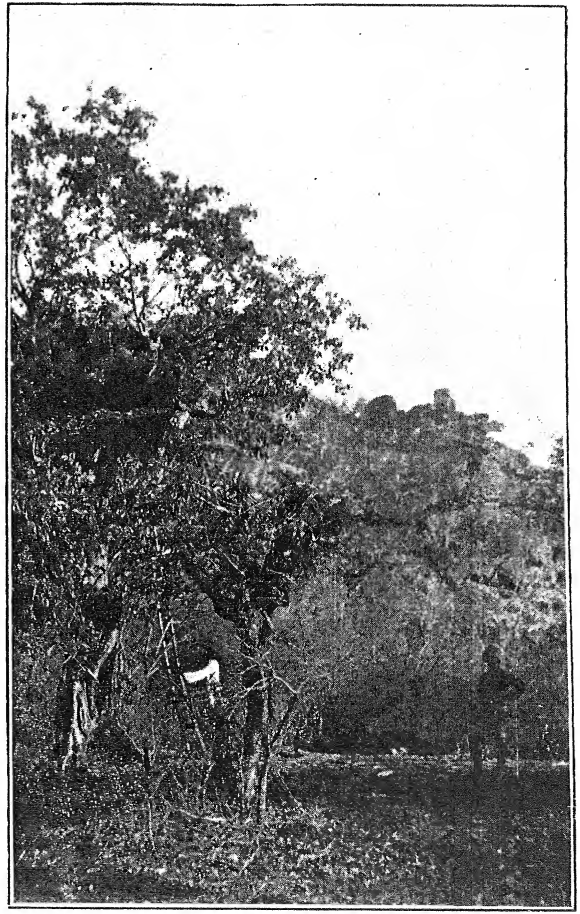
So much for the critics of the practice of sitting up. I have no wish to be dogmatic in the matter; some of my readers may think differently. I would only ask for dispassionate consideration of my views. Where possible beating is no doubt preferable as more likely to afford a shot and that always in daylight, but sometimes the purse constrains; beating is a much more expensive amusement. There are also times when beaters are not available. And the nature of the country often renders beating quite impracticable, especially for panther. A great point, moreover, in favour of sitting up, which is not appreciated by those who have not given it a fair trial, consists in the opportunities it affords to the lover of Nature of attaining a greater intimacy with his Mistress and of being initiated into some of the secrets of the jungle. Sitting up, too, is an excellent discipline. It is no game for the man who cannot possess his soul in patience and may be termed monotonous by those who have no thoughts beyond the actual killing of their quarry. For me it has a great charm, as it must always have for those who love the jungle or have in them anything of the naturalist. There is a fascination which never palls, especially if you are in the heart of the jungle, in that silent watch and ward as you listen to the gradual awakening of the voices of the night around you. And never in the daylight can one experience quite the same kind of thrill as when one becomes conscious of the near presence of a wild beast, invisible in the gloom of night.

Like many other wild animals both tigers and panthers will often fail to notice or identify a motionless object, but their eyes are marvellously quick to detect the least movement around them. Their ears are equally sensitive. They are also by nature extremely wary and suspicious. To an insufficient appreciation of these characteristics is due the failure of many an unrewarded vigil.

It follows that in making one's preparations it should be one's aim to avoid anything likely to arouse suspicion and to make oneself as invisible as possible. To deal first with sitting up for a panther over a live bait:—The mere fact of a single goat being tied up alone may be sufficient to arouse the suspicions of a panther



A Panther's Haunt, Idar.



A good Machan.

of experience, but will not as a rule deter him from attacking if, after studying the situation, he detects no sign of the presence of man. To begin with: I assume that a panther has been approximately located, probably by his tracks—it may or may not be after a kill—in some particular hill or patch of jungle. The first thing to be done is to select a site for the *machán* in a quiet spot within a moderate distance of the beast's retreat—not so near as to run a risk of disturbing him, but near enough for the goat's calling to be audible in the proximity of his lair. The most usual site for a *machán* is a leafy tree, though a sheltered rock or a thick bush with a bank behind will sometimes afford an excellent position. A platform of stout branches is made in the tree or—this is what I have generally used—a native *charpoy* may be slung up and securely fastened by ropes among the branches, with a native quilt or two and a couple of cushions, or a round stool to sit upon and give your legs freedom. This may sound *sybaritic* but is merely common sense. You *must* be able to keep still or, if you have to make an occasional movement, to do so without noise. This is impossible if you are not comfortable.

The foliage of the tree, alone, will rarely, especially in the hot weather, provide adequate concealment. It is therefore necessary to screen yourself all around with branches. An effective method of doing this is by means of light hurdles made of leafy branches, preferably of the same kind of tree as that which holds the *machán*. Such hurdles are best constructed at a distance so as to take less time in the actual preparation of the *machán* on the spot. In the front screen facing the goat a loophole is constructed, with a firm cross-bar at a convenient height on which to rest your rifle; this is important. If you are anxious to get your shot before dark, it is sometimes advisable to have another loophole or two for use in one or both of the side screens to command a probable line of approach.

This last provision for a good view, however, must not be overdone. I am convinced that the most frequent cause of failure is inadequate concealment of oneself. Colonel Stockley writes of 'so arranging things that you have a good view all round' but it is significant that he has had little success in sitting up. I used once to be of the same opinion—in those days the panther kept away! As a rule it is best to be content with a loophole in front only, with perhaps a small peephole on one side.

One always knew in theory that a panther was a wary beast and quick of sight and hearing, but the superlative quality of his watchfulness was not really brought home to me until I had had opportunities, watching in my turn, of observing it for myself. I have seen a panther sit or lie watching his 'kill' or a tied up goat for more than an hour at a time. I have seen one sit staring at my *machán*—I knew it was not a good one, nor well placed—from a distance of eighty yards and then slip quietly away never to return. On many another blank evening that is doubtless what has happened, the panther has taken observations, himself unseen.

No doubt a good field of view might sometimes enable you to see the panther earlier and give you a daylight shot, but it is not worth

the risk of his spotting some slight movement from one direction, while you are gazing in another.

The case of a *machán* in a beat is different. Then you can expect only the one chance as the beast passes by. You cannot be quite certain what line he will take and there is no inducement—as in the case of bait or kill—to make him come and give you an easy shot at close quarters. A good field of view and of freedom to shoot in different directions, becomes, therefore, of great importance in a beat, for which reason also a rest for the gun is then a mistake, being liable to get in the way. Moreover, your quarry in a beat has no reason to be specially on the look-out for danger at the precise spot where you are stationed as he has in the case of kill or bait. It is of course desirable to be inconspicuous so far as possible but the need for concealment is much less, while the need for a good view and field of fire is much greater in a beat than when sitting up.

In this connection the matter of height of your *machán* has to be considered. The higher you are, the less likely to be seen. At the same time, especially at night, accurate hitting is definitely not as easy from a height as on the level. In my opinion about fifteen feet above ground is best. I do not like a *machán* above twenty feet.

It is important to make sure that there is no background of clear sky behind your head: a slight unavoidable movement in shadow may pass unobserved, even by a panther's keen eye, which against the sky would be noticed at once. It is a wise precaution to place a man in the *machán* when it is ready and study appearances yourself from outside.

Another matter which may make all the difference is the location of your tree relative to the beast's probable line of approach and the position of the bait or kill. When possible your tree should not be an isolated one; if there are others around it is less likely to invite a beast's particular attention. It may sometimes be impossible to judge from which direction a tiger or panther will come and in any case he will often prowl all round before coming near. But, especially if the *machán* be at the base of a hill in which he is known to have lain up, one may often judge correctly his most probable line of advance. In such a case it is advisable that the *machán* should not be situated in his direct line of sight as he approaches but, if possible, to one side. Though making observations all around, his attention is directed mainly towards the bait or kill; therefore anything suspicious about a *machán* beyond the bait but in the same general line of sight is more likely to attract his notice than if the position be looking towards the bait from one side. If your *machán* is between the panther and the bait you run the risk of his approaching from behind you unseen and unheard and possibly halting beneath or near your tree where he is liable to hear your slightest movement. I have known a panther to sit exactly beneath my *machán* and depart without my having had any suspicion of his presence until examination of his tracks afterwards told what had happened!

The distance of the *machán* from bait or 'kill' is another factor of importance. The greater the distance the less chance of your being detected. If you do not mean to sit after the light has faded

forty yards is not too far. But by good moonlight or when using a flashlight torch twenty to twenty-five yards is the best distance. If, however, you intend to use buckshot on a panther, from fifteen to eighteen yards is far enough with a cylinder barrel.

There are times when no suitable tree is available. If there are high bushes to afford cover a platform on four poles may be an adequate substitute. Otherwise, in the absence of a tree, an efficient hide can often be made among bushes or rocks or on the bank of a nullah. In such a case it is as well to arrange so that a wounded beast cannot easily get at you in the event of things not going quite right!

With regard to your conduct of affairs when in the *machán* it should be unnecessary to say that patience and quiet watchfulness are essential. If you have to move—and there are times when you must—your movements must be deliberate and of the slowest. If you propose to sit late and have food with you, see that it is not wrapped in paper that will rustle, and avoid tins. As General Wardrop most truly writes 'the sound of metal on metal is the danger signal of the jungle,' so be most careful of your weapons, cartridges, whistle—anything of metal. I have occasionally known a signet ring on my finger to knock against a rifle barrel, so now I always make a point of removing it.

You must be careful to avoid having any dry leaves on the *machán* close to your loophole or in any place where there is a risk of your touching them and causing them to rustle. Do not have your loophole too large, but see that its edges are fairly clear cut; a projecting leaf or twig which may be of no importance in daylight can become a serious impediment to clear vision in the dusk. With the question of actually shooting in the dark I will deal presently.

While dry leaves in the *machán* might betray you, they may on the ground betray the approach of the panther. There are, therefore, occasions when they can with advantage be spread at the foot of your tree.

Practically all that I have said so far applies in equal measure whether you are sitting up over a goat or a 'kill'. But there are further special considerations to be taken into account in the case of a 'kill'. The natural instinct of the wild beast would seem to lead it to apprehend the possibility of an enemy having found its kill and seized the opportunity of lying in wait for its return. Hence, presumably, the caution usually displayed in returning even to a natural 'kill', by which I mean a kill obtained in the ordinary course of hunting and not of an animal tied up as a bait. This caution is intensified by the suspicions aroused by a tied-up bait especially when, as is often the case, the tiger or panther has learned from previous experience the risk of danger associated with such.

It follows that a natural kill is the best. But this is not usually to be found just when you want it. And when one does occur, the corpse of the victim is by no means always left in a place commanded by a suitable site for a *machán*. Moving a 'kill' is not to be recommended.

Apart from the fact that the moving of a 'kill' engenders suspicion, the powers of scent of the great cats are poor. A panther

has been seen to scent up the drag of a 'kill' that has been moved, but you cannot count upon his doing so and I doubt if a tiger will ever do it. If, therefore, it be absolutely necessary to do so at all, do not move a 'kill' more than a few yards and then not out of sight of its original resting-place.

If then you want a 'kill' to sit over—and failing a natural one—you must first choose your *machán* site in a likely place and tie up your bait securely so that it cannot be dragged away. Presumably in order to take advantage of the better field of view, both tiger and panther habitually perambulate along the jungle paths. The junction of two paths or nullahs or of a path and a nullah is therefore a good place.

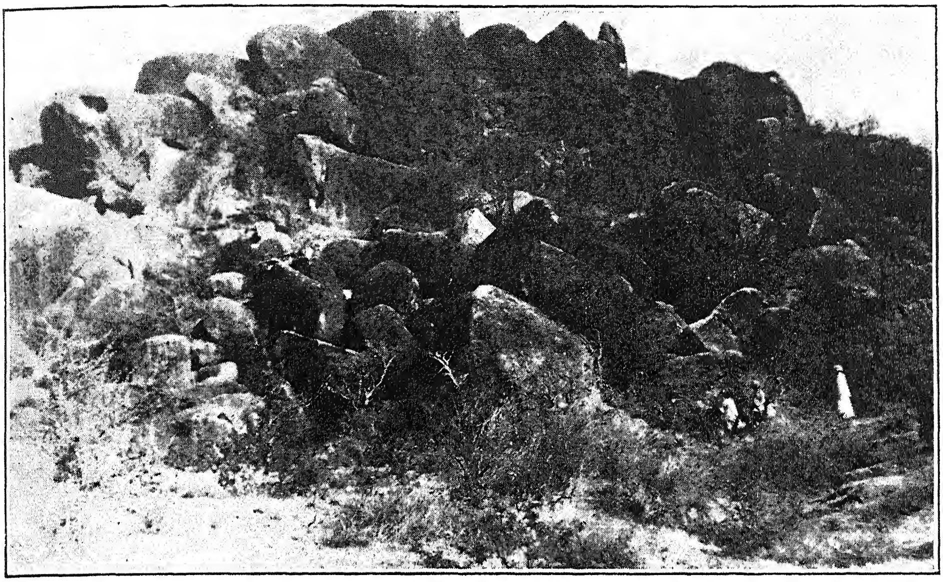
You may have baits tied up at several spots. It is worth while having a *machán* made beforehand at the likeliest of these. You will then avoid the risk of the beast being disturbed by the noise of the erection of the *machán*. When you have to put up your *machán* after the kill has been made, and there is a likelihood of the beast being within hearing, it is sometimes a good plan to send a couple of men moving in the direction in which he is believed to be, the object being to disturb him sufficiently without scaring him, in order to make him move out of hearing. But this requires to be done with judgment.

So far as possible there should be nothing suspicious about the *machán*, to catch the panther's eye, which was not there when he made his kill. The work of constructing the *machán*—after a kill—should, if practicable, be finished by 2 p.m. You can never be sure when a tiger or panther will return to his kill. It depends upon place and circumstances, upon the idiosyncracies of the particular beast and the state of his appetite. When the 'kill' is in a secluded place and he has lain up near by he may return at any hour, but as a general rule it is advisable to be settled down in your *machán* by 4 p.m. in the cold, and 5 p.m. in the hot weather, at latest.

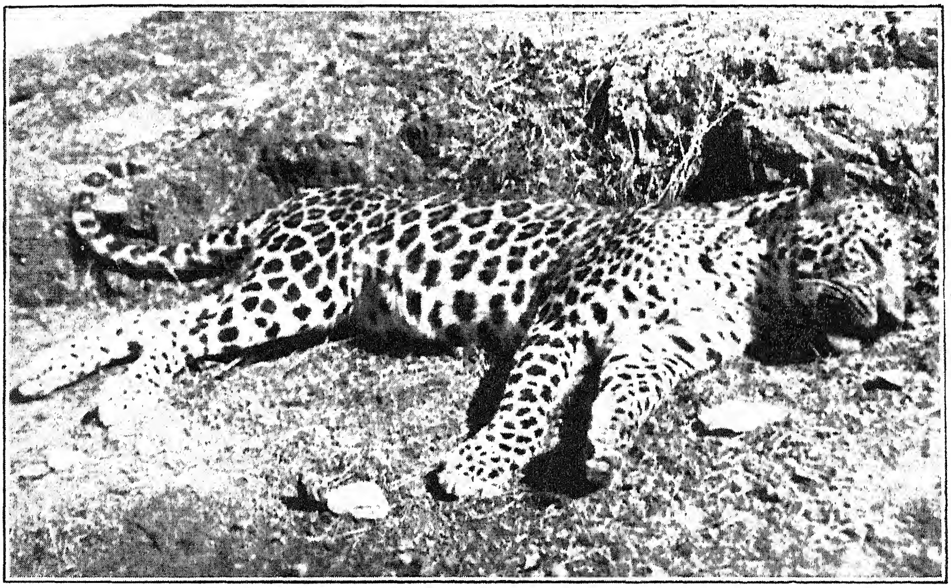
In my experience it is rarely worth while sitting up for a panther for much more than an hour after dark. If not suspicious of danger he will often appear before the sun goes down, but the most likely time is the hour immediately after sunset. My experience of tigers is limited. I have shot one tigress over a kill in bright sunshine, but as a rule they are later than panthers, and, if it is not too cold, you should be prepared for an all night vigil. General Wardrop says that if a tiger does not arrive by 9 p.m. he is most likely to turn up about midnight or at dawn.

A good bait for a male panther is a young male buffalo from six months to a year old. A goat may be completely devoured or not enough left for a second meal. A buffalo kill in my experience usually ensures a return if nothing has made the panther suspicious.

If you intend to sit after dark the question of light becomes of importance. If the moon be near the full, well and good; but even then moonlight can be very deceptive. It must also be borne in mind that it is as important to see your foresight as it is to see your target. This you will be unable to do if the moon is in your front or its light cut off from your rifle barrel by thick foliage. Consequently the position of the moon may be an important factor



Mahi Kantha Panther Country. The scene of ' a right and left '.



A Mahi Kantha Panther.

in the placing of the *machán*. If there be a moderate amount of light an old tip that I have found useful is to affix, with a rubber band, a white visiting card behind your foresight. Luminous paint may also be made to serve your need.

None of these devices, however, is really satisfactory. Shooting in the dark is a very futile business unless you can see your quarry well enough to distinguish its position and make sure of being able to place your shot, and to do the latter you must see your foresight. The old hand does not need to be told, but it cannot be too strongly impressed upon the novice that accuracy first, last and all the time must be his object. Apart from the fact that you want to bring your game to bag, any sportsman worthy of the name must hate the idea of merely wounding. In the case of dangerous game, moreover, there is the further consideration that a wounded beast is a menace to anyone who may accidentally cross his path. The great cats are tenacious of life and it is quite useless to hit them just anywhere. Their striped or spotted coats blend at night into a faint neutral shadow and make them practically invisible in a dim light where a dark or light coloured animal would be distinctly seen. Even in bright moonlight a beast's outline is often amazingly indistinct unless its visible side is in the shadow.

If you have no means of lighting up your target it is not a bad plan to scatter some bran or flour around the 'kill' so as to make a light background against which on a clear starry night a panther will show up faintly as a darker shadow. I have obtained the same result by a judicious spreading of the hay or straw which had been furnished for use of the tied-up buffalo the night before. But on the whole I certainly do not recommend trying to shoot in the dark or in a dim light unless you are provided with some form of electric light with which to throw a sudden illumination on the scene. Personally, I have entirely given up attempting the game after dark without such aid.

A good electric lamp makes all the difference. There are several devices of the kind on the market. One is a lamp with a shade intended to be hung above the 'kill' and throw a light directly down upon it; a controlling wire is connected to the *machán*. I have not tried this, but it seems to me a weak point that a fixed area only can be lighted up, while it may not always be possible to fix it in the right position above the 'kill'. A better method is provided by a lamp fixed in the *machán* with movable bull's eye which can be adjusted to throw its beam in the required direction. This is the type of lamp advised by General Wardrop who has used it with great success.

The only kind to which I have given a fair trial—and found very successful—is a powerful cylindrical spotlight focussing torch which is clamped to one's gun-barrel so that gun and light are together aligned upon one's target. This torch throws a beam of light which effectively lights up the 'kill' at a distance of twenty to twenty-five yards. It also has the great advantage of, at the same time, illuminating one's foresight. If the light be suddenly thrown directly into an animal's eve it may frighten him off. If, however, the light strikes the eyes from the side he will usually look up and

stare, giving you plenty of time for a shot. If the light does not strike his eyes the beast will in my experience take no notice whatever. I have only found one disadvantage, that the process of clamping on the torch may be a trifle noisy; it is therefore advisable to affix the lamp to the gun quietly, at your leisure, before it is quite dark. A point of special importance with this lamp is the necessity for a rest for one's gun-barrel, without which the weight of the toreh will tend to drag down the foresight to one side. But it is advisable in the interests of silence to wrap a cloth round the cross-bar. Here, again, a question of ethics has been raised. There are some who consider sitting up by daylight permissible, but would bar the use of an electric light at night as 'unsporting'. So far as I understand, the objections are two :—

(*a*) That it makes the business too easy,

(*b*) That it encourages shooting at night and thereby increases the risk of merely wounding.

These objections are mutually contradictory. In any case the first may be dismissed in a word : it is merely absurd to suggest that it is easier to shoot with an electric lamp than in broad daylight. The second objection is little more difficult to deal with, if at greater length. An inadequate illumination is hardly better than none at all. But there are several makes of suitable and inexpensive lamps to be purchased nowadays which possess ample power : it is only necessary to be careful that the battery does not get exhausted; wherefore in a sporting trip a couple of spare batteries should be carried. And it is reasonable to assume that no intelligent sportsman will go to his *machán* without testing the capabilities of the lamp he intends to use.

Granted an efficient lamp and the fixing of the *machán* at a distance from the kill commensurate with its power, it is for practical purposes little more difficult to place one's shot accurately than in daylight, when the range would often be much longer. There is, consequently, no appreciably greater risk of wounding. Further, the general arguments in favour of sitting up are equally applicable in this particular case. Just as it is often impossible to get a shot at an animal except by sitting up, so, having sat up, it is often equally impossible to get a shot in daylight at an individual animal which makes a practice of never returning to its 'kill' before dark. What is strongly to be deprecated is shooting in the dark or in so bad a light that reasonably accurate aim cannot be taken.

I have dealt at some length with the theory and practice of the art of sitting up, but it has seemed worth while to discuss the subject in detail. In subsequent parts I propose to illustrate what I have already said by describing some personal experiences of the panther and his ways—both by night and day.

(*To be continued*)

THE MONITOR LIZARDS OF BURMA.

BY

H. C. SMITH, I.F.S.,
Deputy Conservator of Forests,
Game Warden, Burma.

(*With two plates.*)

General.—Monitor Lizards, 'Phuts', as they are called in Burmese, are carnivorous terrestrial and aquatic reptiles belonging to the family *Varanidæ* of the order *Squamata.* Five species are known to occur in Burma, all of which belong to the one genus, *Varanus.*

The tongue is smooth, very long and slender, bifid and retractile into a sheath at the base.

The teeth are large and dilated at the bases which are fixed to the inner sides of the jaws.

They lay oval soft shelled eggs.

'Phuts' are much sought after by Burmans for the sake of the flesh which is said to resemble that of a fowl, and the eggs which are considered great delicacies. The jungle villagers usually hunt for them with dogs.

There appear to have been no organized attempts as yet to collect these lizards for the sake of their skins in Burma.

Identification.—The identification of the species, which depends upon the shape and position of the nostril, the type of ventral scales and the shape and arrangement of the supraocular scales is by no means easy especially in the case of dried skins. For identification purposes the head and a portion of the skin from the belly will suffice if carefully preserved.

Key to the SPECIES

A. Nostril an oblique slit.

I Nostril a little nearer to end of snout than to orbit ... ... 1. YELLOW MONITOR (*Varanus flavescens*)

II Nostril nearer to orbit than to the end of snout.

(*a*) Ventral scales smooth.

i. All supraoculars equal. Nostril much nearer to orbit than to end of snout ... ... 2. COMMON MONITOR (*Varanus bengalensis*)

ii. Median supraoculars slightly enlarged transversely. Nostril a little nearer to orbit than to the end of snout	3. CLOUDED MONITOR (*Varanus nebulosus*)
(*b*) Ventral scales keeled. Nuchal scales very large and flat	4. DUMERIL'S MONITOR (*Varanus dumerilii*)
B. Nostril roundish or oval, nearer to end of snout than to orbit ...	5. WATER MONITOR (*Varanus salvator*)

1. THE YELLOW MONITOR.

(*Varanus flavescens.*)

Local names.—Phut. Phut-Gya (*Burmese*).

Description.—' Teeth subconical, scarcely compressed. Snout short, convex, measuring a little less than the distance from the anterior border of the orbit to the anterior border of the ear; canthus rostralis distinct. Nostril an oblique slit, a little nearer to end of the snout than to the orbit. Digits short, the length of the fourth toe, measured from its articulation with the tarsus to the base of the claw, not exceeding the length of the femur. Tail feebly compressed, keeled above. Scales of head small, subequal; the median series of supraocular scales slightly dilated transversely. Scales on upper surface moderate, oval, keeled. Abdominal scales smooth, in 65 to 75 transverse rows. Caudal scales keeled; the caudal keel with a very low, doubly-toothed crest. (*Fauna.*)

' *Colour.*—Olive or yellowish brown above, with irregular darker markings which are generally confluent into broad cross bars; a blackish temporal streak; lower surface yellowish, with rather indistinct brown cross bars, which are most distinct on the throat.

' Young, dark brown above, with yellow spots confluent into cross bars; lower surface yellow; with dark brown cross bars.' (*Fauna.*)

Measurements.—' From snout to vent, 1 foot 3 inches; tail, 1 foot 8 inches.' (*Fauna.*) Total length about 3 feet.

Distribution.—' North India, Burma and Malay Peninsula.' (*Fauna.*) I have not yet met with this species in Burma.

Habits.—' Terrestrial.' (*Fauna.*)

2. THE COMMON MONITOR.

(*Varanus bengalensis.*)

Local names.—Phut, Kon-phut, Phut-Mwe (*Burmese*).

Description.—' Teeth acute, compressed, snout high, very convex at the end, as long as the distance from the anterior corner of the

MONITOR LIZARDS OF BURMA.
Common Monitor (*Varanus bengalensis*)

eye to the ear ; canthus rostralis well marked. Nostril an oblique slit, a little nearer to the orbit than to the tip of the snout. Ear-opening oblique. Digits strong, moderately elongate. Tail compressed, keeled above. Scales of head small, subequal; supraocular scales smaller, subequal. Scales of upper surface of body and limbs small, oval, tectiform on the hinder part of the back. Abdominal scales smooth, in 90 to 110 transverse rows. Caudal scales keeled; caudal keel with very low doubly-toothed crest.' (*Fauna*).

'*Colour*.—Yellowish, brownish, or olive, with more or less numerous blackish dots ; a more or less distinct dark streak on the temple ; lower surface yellowish, uniform or dotted with blackish ; the dots most numerous on the throat.

'Young with numerous whitish ocelli frequently alternating with blackish transverse bands, which may persist after the ocelli have disappeared (*V. lunatus*).' (*Fauna.*)

Measurements.—'From snout to vent 2 feet 6 inches, tail 3 feet 6 inches.' (*Fauna.*) Total length about 6 feet.

Distribution.—'The whole of India and Ceylon, Burma.' (*Fauna.*) Occurs practically throughout Burma preferring the drier parts.

Habits.—'Terrestrial, living in holes in dry places.' (*Fauna.*)

This monitor, called by the Burmans the 'Land' Monitor or 'Grey' Monitor, is the most generally distributed of all the monitors in Burma. It is found almost everywhere, but is particularly partial to the drier forests. It may occur in remote forests and also in compounds in and on the outskirts of stations and villages.

These lizards are much sought after by the local people who consider the flesh and the eggs great delicacies. They usually hunt for them with dogs. When chased, these monitors usually make for a hollow tree, typically running up the perpendicular bole with great ease and disappearing down a hole at the top. A Burman will think nothing of felling a valuable tree of five feet girth or more in order to bag a 'Phut' which has taken refuge inside it.

In the hopes of escaping observation or capture, these lizards will often lie absolutely motionless in the open on the ground or against the bare trunk of a tree, and, when behaving thus, they can often be picked up by the tail or will allow a noose at the end of a long pole to be slipped over their heads. They harmonize well with their surroundings and so, when motionless, are often difficult to spot.

Common Monitors most often met with are about 3 to 4 feet in length from snout to tip of tail, but there is little doubt that they run twice or even three times that size. Some enormous specimens have been seen in the extensive *indaing* (dry dipterocarp) forests in Upper Burma.

They can run at a great pace on the ground and when travelling thus, the tail is held up at an angle of about 45° from the ground.

When cornered and afraid or angry, this lizard has a habit of raising itself on its fore-legs and inflating itself with air to its

utmost capacity. The air is then expelled to the accompaniment of a noise resembling that made by dragging a tarpaulin or tent along the ground. The noise and the ferocious attitude assumed are evidently intended to strike terror into the heart of an assailant.

It defends itself against a dog by lashing with its tail, generally snapping with its mouth at the same time.

They can bite hard and, owing to the teeth being directed backwards, they are difficult to dislodge when once they have got a firm hold.

When captured, they are generally found to have numerous ticks adhering to them which, in colour and shape, very closely resemble the lizards' scales.

The *breeding season* of the Common Monitor is said to be during the hot weather, viz., the end of March and April. It is said to commence breeding in its second or third year when it has attained a length of about 2 feet 6 inches or 3 feet. It deposits its eggs, which are white, oval, soft-shelled and often as many as 25–30 in number, in a hole in an ant-heap. The eggs are separate from each other and not stuck together like snakes' eggs. They are laid usually early in the hot weather. After depositing her eggs, the female 'Phut' closes up the hole with leaves, rubbish, etc., and departs.

The *food* of these monitors consists of small mammals, birds, fishes, frogs and eggs. They will eat raw meat in captivity. They are capable of existing for a considerable time without food and will gorge themselves when opportunity arises. They are known to be very destructive in poultry yards, but the damage done in this way is believed to be more than counteracted by the amount of good these reptiles do by devouring large number of rats and mice which would otherwise destroy field crops.

3. The Clouded Monitor.

(*Varanus nebulosus.*)

Local names.—Phut, Kon-Phut. (*Burmese.*)

Description.—' Teeth acute, compressed. Snout rather elevated, pointed, convex, as long as the distance from the anterior corner of the eye to the posterior border of the ear; canthus rostralis distinct. Nostril an oblique slit, half as far from orbit as from end of snout. Ear-opening oblique. Digits moderately elongate. Tail compressed, keeled above. Scales of head small, subequal; supraocular region with a series of four to seven transversely dilated scales. Scales on upper surface small, oval, obtusely keeled, those on anterior part of neck larger, sub-circular, not keeled. Abdominal scales smooth, in about 80 transverse rows. Caudal scales keeled; the caudal keel with a very low, doubly-toothed crest.' (*Fauna.*)

'*Colour.*—Greenish or brownish olive, irregularly marbled and dotted with darker and lighter; chin and throat with transverse blackish bands or marbled with blackish.

'Young have numerous yellowish ocelli on the back, limbs, and base of tail, and the whole of the lower surface marbled with

blackish; nape with two posteriorly directed, chevron-shaped bands, the anterior proceeding from the eyes.' (*Fauna.*)

Measurements.—' From snout to vent 1 foot 2 inches; tail 2 feet.' (*Fauna.*) Total length about 3 feet.

Distribution.—' Bengal, Burma, Siam, Malay Peninsula.' (*Fauna.*) Rare in Burma as compared with the Common and Water Monitors.

Habits.—Nothing specially recorded. Probably vary similar to those of the Common Monitor for which it is no doubt often mistaken.

4. Dumeril's Monitor.

(*Varanus dumerilii.*)

Local names.—Phut (*Burmese*).

Description.—' Teeth acute, compressed. Snout depressed at the end, measuring a little more than the distance from the anterior border of the orbit to the anterior border of the ear; canthus rostralis not well marked. Nostril oblique, about half as far from orbit as from tip of snout. Digits moderate. Tail strongly compressed, keeled above. Scales of head moderate, subequal; those in the middle of the supraocular region slighlty enlarged transversely. Scales on upper surface of neck very large, about as broad as long, flat, the hindermost slightly keeled; dorsal scales large, oval, keeled; scales above the limbs keeled. Abdominal scales slightly keeled, in 75 to 85 transverse rows. Caudal scales keeled, the lateral sometimes intermixed with larger ones; the caudal keel with a very low, doubly-toothed crest.' (*Fauna.*)

' *Colour.*—Light brown above, a dark temporal streak, from eye to ear, generally confluent with a U-shaped dark marking on the neck; back with very broad dark transverse bars, broader than the interpaces between them; limbs dark brown, spotted with yellow; more or less distinct vertical dark bars on the lips; belly yellowish, uniform or with transverse dark bands.' (*Fauna.*)

Measurements.—' From snout to vent, 1 foot 3 inches.' (*Fauna.*) Total length about 5 feet.

Distribution.—' Tenasserim, Sumatra, Borneo.' (*Fauna.*)

Noted specially on islands in the Mergui Archipelago and in mangrove forests along the coast of Mergui.

Habits.—Terrestrial and aquatic and also apparently marine.

Noted lying on the uncovered mangrove roots in the tidal creeks of Mergui.

Plentiful on Sir Charles Forbes' Island where, if roused by dogs in the dense evergreen which grows right down to the coast, these monitors bolt across the beaches to take refuge in the sea. Some exceptionally large tracks of monitors were seen in the sand alongside creeks on this island, some being about the size of a bear's; they might have been made either by the Water-Monitor (*Varanus salvator*) or by *Varanus dumerilii.*

One good specimen was killed on Sir William James' Island. It ran out of a small pool (in which pig had been wallowing) on the crest of a ridge, then up a large tree.

5. The Water-Monitor.

(Varanus salvator.)

Local names.—Phut. Yay-Phut. Phut-Hyin-gan. Phut-Kyi (*Burmese*).

Description.—' Teeth, acute, compressed. Snout depressed at the tip, long, the distance from that point to the anterior corner of the eye being generally a little greater than the distance from the latter to the anterior border of the ear; canthus rostralis obtuse. Nostril, oval, at least twice as far from the orbit as from the tip of the snout. Digits moderate. Tail strongly compressed, keeled above. Scales of head moderate, subequal; supraocular region with a series of 4 to 8 large, transversely dilated scales. Scales on the upper surface small, oval, keeled; abdominal scales keeled, in 85 to 95 transverse rows. Caudal scales keeled; the caudal ridge with a very low, doubly-toothed crest.' (*Fauna.*)

' *Colour.*—Dark brown or blackish above, with yellow spots or ocelli; snout generally lighter, with transverse black bars, most distinct on the lips, and continued across the chin; a black temporal band, commencing from eyes and bordered by a yellow band which sometimes extends along the side of the neck; lower surface yellow.' (*Fauna.*)

Young have the markings accentuated and are extremely beautiful.

Measurements.—' From snout to vent 3 feet 4 inches.' (*Fauna.*)

Total length about 5 feet, probably often reaching 8 to 10 feet or even more.

Distribution.—' Bengal, Ceylon, South China, Malay Peninsula and Archipelago. Found in marshy localities or on trees overhanging rivers.' (*Fauna.*)

Quite plentiful throughout Burma in suitable localities. Most frequently met with near streams in remote evergreen forests specially on the islands of the Mergui Archipelago.

On March, 24 1923, whilst exploring the central portion of Charles Forbes' Island, I killed a hamadrayad, measuring 14 feet 9 inches, which had apparently just killed a Water Monitor which measured 4 feet 9 inches (total length). The snake, when first seen, was ' mouthing ' the lizard in a quiet, self-satisfied sort of way and ignored the presence of myself and four other people who walked past within eight yards of it in quite open jungle. After watching the snake for a few minutes, we shot it.

Water Monitors are particularly plentiful in the neighbourhood of Mandalay where they live in the canals and irrigation channels and the thick patches of scrub jungle, often submerged during the rains, which occur along the banks. Specimens 6 feet and more in length are frequently seen dashing across the Mandalay-Maymyo main road in front of motors.

Habits.—' Enters the water readily.' (*Fauna.*)

This monitor, though mainly aquatic, can apparently exist for long periods in dry regions without any water at all.

On May 11, 1924, whilst working through some very dry forests in Mongmit State in search of *saing*, I saw a large Water-Monitor

MONITOR LIZARDS OF BURMA.
Young Water Monitor (*Varanus salvator*).

floundering about in a small pool. It offered little resistance to the Burman who dragged it out by the tail and proved to be a female 5 feet in length. When captured, a live frog jumped out of its mouth and later, when cut open, its stomach was found to contain no less than 40 more frogs, none of which were particularly small. The lizard was absolutely gorged. The place where it was found was where some days before we had failed to get a drop of water even by digging 4 feet for it. The heavy rain overnight had brought out all the frogs and the 'Phuts' were evidently making the most of their opportunities.

These monitors, when startled, will usually take refuge in water where they can remain submerged for a considerable time. They can, however, travel at a good pace on land and invariably make good their escape if the jungle is at all thick.

When cornered, they lash with their tails and snap like the Common Monitor and they blow themselves out with air which they expel with a hissing noise, presumably to terrify their assailants.

The *breeding season* is said to be later than that of the Common Monitor, the eggs being laid at the beginning of the rains. A full-grown female will lay 25–30 eggs which resemble those of the Common Monitor. They are usually laid in holes in trees near or overhanging water.

The *food* of the Water-Monitor consists mainly of fish and frogs. It is known to be very fond of eggs and destructive to poultry and it will also no doubt eat various small mammals and birds.

THE VALUE OF FIELD OBSERVATIONS IN THE STUDY OF ORGANIC EVOLUTION.

BY

SUNDER LAL HORA, D.SC. (PUNJAB), D.SC. (EDIN.),

F.R.S.E., F.L.S., F.Z.S., F.A.S.B.

(With nine text figures.)

(Presidential address delivered before the Section of Zoology, Seventeenth Indian Science Congress, Allahabad, 1930.)

'Zoology, like all other branches of Natural Science, has had two lines of progress, observation and generalization. Without accurate and detailed knowledge of the facts and phenomena of animal life and structure, all theories of classification or of origin are so much idle speculation: in the absence of the philosophic spirit suggesting hypothesis of greater or less magnitude, the mere accumulation of facts is an empirical and barren study.' (Parker and Haswell, 1910, p. 668.)

For a biologist there is no problem of greater interest than the study of Organic Evolution. No one doubts to-day that evolution is a fact, but how it is caused is the main problem that still awaits solution. Several theories have been advanced to explain the method of organic evolution, but none has met with unanimous scientific approval, and though each theory explains a certain number of facts, not one is sufficiently comprehensive to cover them all. To tackle this evasive problem several methods have been devised and considerable progress has been made along each. At the present day, however, there is an increasing tendency to advocate the experimental method in preference to the observational method of the older naturalists. According to Professor Julian S. Huxley, it is unthinkable that any attempt should be made 'to raise any theory of the *method* of evolution on observational data alone,' but such workers evidently seem to forget that the theory of 'evolution is a philosophy of wild nature'. It relates to animals living under natural conditions, outside the domain of the laboratory worker and in that of the field naturalist. The laboratory-trained zoologist lacking in field knowledge often shows a singular incapacity for understanding the importance of evolutionary factors which experience in the field, more especially tropical experience, drives home. (Kerr 1926, p. 9). Professor D. M. S. Watson in his presidential address to the Zoology Section of the British Association for the Advancement of Science last year concluded that 'the present position of zoology is unsatisfactory,' and that the 'data which we have accumulated are inadequate.' In Professor Watson's opinion 'the experimental method rightly used will in the end give us, if not the solution of our problem, at least the power of analysing it and

isolating the various factors which enter into it.' To me, however, it seems that the inadequacy of our accumulated data is mainly due to the fact that the study of the environment has not kept pace with the study of the organism. It is impossible to understand the life mechanism of an organism without an adequate if not thorough, knowledge of the numerous factors that influence its life in an environment, for 'Organism and environment must be thought of as a unity, as interlocked and fitted closely to form that harmony which is Nature and life' (Allen 1929, p. 841). It follows, therefore, that the first requisite in the study of evolution is to understand the true relationship between an organism and its habitat. Once this relationship has been established, experiments in the laboratory may be very instructive and useful, but if laboratory observations precede field observations care must be taken that they do not lead to any unjustifiable conclusions for after all—'evolution is a philosophy of wild nature.'

To my mind the best method of studying the correlation that exists between an animal organization and its habitat is to make direct observations, to supplement them afterwards by making experiments in the field under natural conditions and then, if need be, to subject the organism to experiments in the laboratory. The late Dr. N. Annandale was a great believer in the observational method and his Presidential Address to the Science Congress and a number of his other contributions are sufficient to show his appreciation of its immense value. I had the good fortune to work under the guidance of this great teacher for a number of years both in the field and in the laboratory and as an humble tribute of appreciation of his teaching I have chosen as the subject of my address 'The Value of Field Observations in the study of Organic Evolution.'

For a period of ten years I have been interested in studying the structural modifications undergone by the fauna of torrential streams and in this connection I have made extensive observations, recorded in a number of papers, on the torrential fauna of this country. You will excuse me, therefore, if I give here a simple, but very instructive example, from this fauna to illustrate my subject.

All of you know that a fish is capable of maintaining its level in water without any great exertion on its part with the help of its air-bladder, which is a buoyancy-giving structure and serves as a hydrostatic organ. Now the problem of maintaining equilibrium at the various strata of the depth of a lake is different from that of remaining at the bottom. In both cases the animal has to react to the mechanical effect of gravity; in the former the desired result is attained by the production of buoyant structures, whereas in the latter the object is achieved by the reduction or total absence of such devices. In a torrent the greatest necessity for life for an animal is to remain as close to the substratum as possible and to meet this demand the air-bladder is greatly reduced in fishes of this habitat. A buoyant fish with a well-developed bladder has no chance to resist a rushing torrent whilst frolicking about in this habitat is a dangerous pastime. Now suppose the fishes of the rapids were compelled to live in a lake, they would be uncomfortable in their attempt to rise to the surface for their heavier build would tend to

keep them close to the bottom; they would not be at home in their new surroundings unless their bladders developed again to make them buoyant. I shall illustrate this hypothesis with examples furnished by loaches of the genus *Nemachilus*. Most of you are, no doubt aware that the Nemachili are commonly found in the hill-streams of India and Burma and that only a few of them are found in slow-running or stationary waters at high altitudes. As a rule the air-bladder in these fishes is greatly reduced and is enclosed in two bony capsules. In a previous paper, (1922, p. 66) I indicated how the normal Cyprinoid bladder, such as that of *Labeo rohita,* becomes gradually modified into a bladder of the *Nemachilus* type and this modification becomes still further marked in highly specialized hill-stream fishes, such as the Homalopterid fish, *Balitora*. I now want to direct your attention here to the reverse changes that have taken place in species of *Nemachilus* living in calm waters at high altitudes.

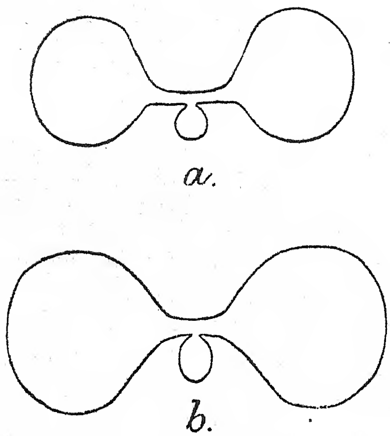


FIG. 1.—Normal type of air-bladder in *Nemachilus*.
(*a*) *N. manipurensis* Chaudhuri, ×10.
(*b*) *N. rupicola* (McClelland), × 10.

In the Inlé Basin, Southern Shan States, Burma, there are four endemic species of *Nemachilus* besides the widely distributed *N. botia*. The habitats of the four species are different and these differences are reflected in the structures of their air-bladders. Specimens of *N. shanensis* Hora were collected in a very fast current in a rocky stream and the species in every respect seems to be highly modified for this habitat. Its bladder is of the normal type. It may be noticed that in this bladder there is a long and narrow horizontal tube that connects the two lateral chambers of the anterior portion of the bladder and that the posterior portion is greatly reduced in size. In *N. rivulicola* Hora, which inhabits clear, rocky streams of the Yawnghwe Valley and the He-Ho plain and several specimens of which were collected by me in a small stream flowing out of a spring near Fort Stedman, the air-bladder has somewhat deviated from the normal type. The two lateral chambers have become enlarged and the tube connecting the two is wider and shorter. The other two species—*N. brunneanus* Annandale and *N. brevis* Boulenger—live in sluggish waters and are commoly found in the Inlé Lake. The former is a slender species closely related to *N. rivulicola* Hora from which it is distinguished by its larger eyes and complete lepidosis. Both of these features, it may be remarked, are characteristic of sluggish water Cyprinoids. In *N. brunneanus* the two lateral chambers are

greatly enlarged and are almost continuous; the connecting tube being represented by a slight constriction only. The posterior

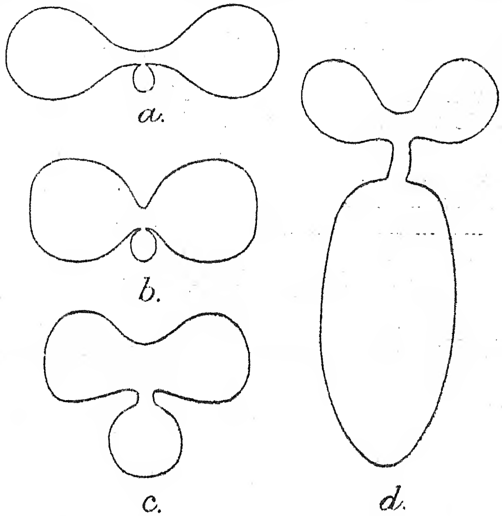


FIG. 2.—Four species of *Nemachilus* from the Inlé Basin, S. Shan States, Burma, showing the gradual evolution of the functional air-bladder.
(*a*) *N. shanensis* Hora, ×10.
(*b*) *N. rivulicola* Hora, ×10.
(*c*) *N. brunneanus* Annandale, ×10.
(*d*) *N. brevis* Boulenger, ×6⅔.

chamber is also enlarged, but its walls are thick and fibrous. In *N. brevis* the posterior chamber is still further enlarged and its walls are thin and elastic. It occupies a considerable portion of the abdominal cavity and is connected with the anterior bilobed chamber by a well-marked tube. There can hardly be any doubt that this air-bladder of *N. brevis* is capable of performing hydrostatic functions as effectively as the normal Cyprinoid bladder.

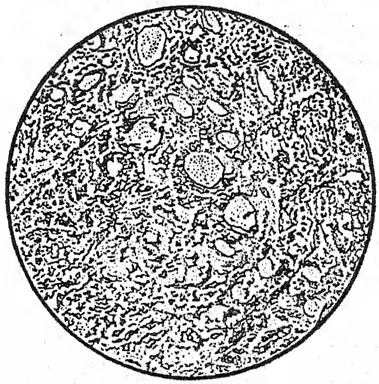


FIG. 3.—A portion of the wall of the bony capsules enclosing the lateral chambers of the anterior portion of the bladder of *Nemachilus brevis* Blgr. (from a photograph).

So far as the structure of the air-bladder is concerned in the four species of *Nemachilus* referred to above, we possess a highly instructive series showing the gradual modification of the structure induced by the direct effect of the environment, and it is also clear that the structural changes are of great utility for they bring about a direct correlation between the organism and its environment. The greatly reduced bladder of *N. shanensis*,

a torrent-inhabiting form, is represented in *N. brevis,* a lake-inhabiting species, by a fully formed hydrostatic organ.

Correlated with the modifications of the bladder described above, there is a series of gradual changes undergone by the bony capsules. As the lateral chambers of the air-bladder increase in size the walls of the bony capsules become thin, and in species like *N. brevis* they are extremely brittle and perforated. Another change that is clearly noticeable even from the outside is that the walls of the bony capsules nearest to the skin on the sides remain incomplete so that the air-bladder comes in close contact with the skin. In these regions of contact the skin becomes thin and translucent. By these modifications the lateral chambers of the anterior portion of the bladder are brought in close contact with the surrounding water, and are enabled to perceive directly the varying hydrostatic pressures to which the fish is subjected in its up and downward movements in deep waters.

I do not want to discuss here the other structural modifications

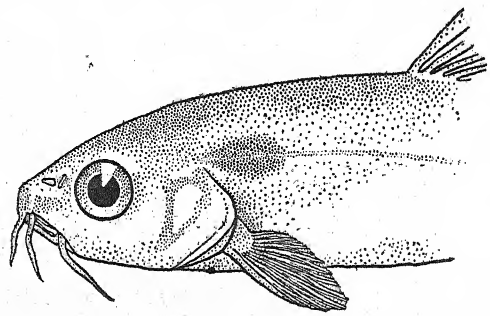


FIG. 4.—Lateral view of head and anterior portion of body of *Nemachilus brevis* Blgr., showing the deeply shaded area where the bladder comes in contact with the skin, $\times 3\frac{3}{4}$.

undergone by these fishes in response to changes in the habitat; for I believe it is fully recognized now that any change in the character of an organism changes the organism as a whole.

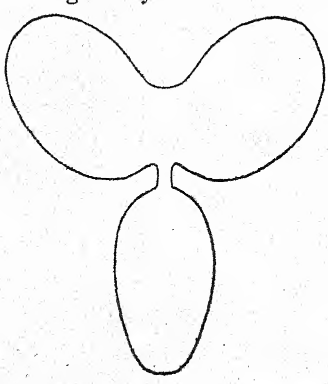


FIG. 5.—Air-bladder of *Nemachilus raoe* Hora, $\times 15$.

The Nemachili from the Inlé Basin are not unique in possessing the modifications described above, for these fishes in other parts of the world, whenever occasion arose, adapted themselves to life in deep waters by a similar, if not identical set of modifications. *Nemachilus raoe* Hora lives in calm waters, for the only specimens of this species known so far were procured by my colleagues Dr. B. N. Chopra and Dr. H. S. Rao from a large tank full of

weeds near the Inspection Bungalow at Mongyai in the Northern Shan States of Burma. In this species the air-bladder is similar to that of *N. brevis* with this difference that the posterior chamber is not so extensive and the tube connecting the two chambers is not so long. Nemachili that inhabit the Kashmir Valley show a gradual evolution of the hydrostatic bladder. *N. kashmirensis* Hora inhabits small streams in the valley and possesses an almost normal type of bladder. *N. marmoratus* (Heckel) lives in ponds and springs and in this species the two lateral chambers of the anterior portion of the bladder are well-developed; the posterior portion is also well-marked but its walls are very thick and fibrous. *N. vittatus* (Heckel) is widely distributed in the sluggish waters of the valley and is commonly found in the Wular Lake; the anterior portion of its bladder[1] has become still further enlarged and the posterior portion, though fibrous and probably inelastic has become of considerable size.

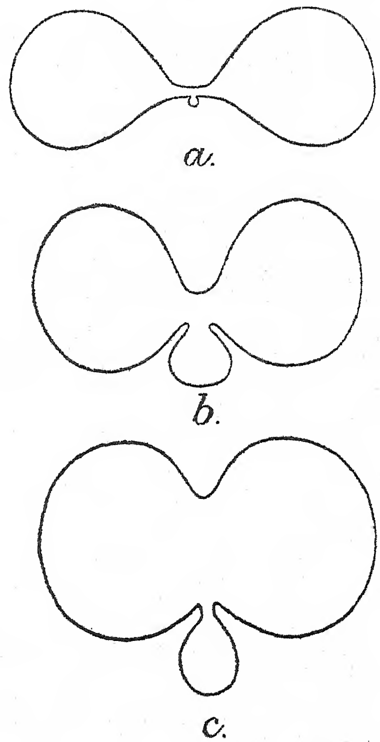


FIG. 6.—Three species of *Nemachilus* from the Kashmir Valley showing the gradual evolution of the functional air-bladder.
(*a*) *N. kashmirensis* Hora, $\times 11\frac{1}{4}$.
(*b*) *N. marmoratus* (Heckel), $\times 11\frac{1}{4}$.
(*c*) *N. vittatus* (Heckel), $\times 6$.

In the highlands of Central Asia there are found certain species of *Nemachilus* in which the air-blader is essentially of the same type as that found in *N. brevis* with this difference that the two portions of the bladder are separated by a considerable distance and consequently the tube connecting the two is thin and long. This condition of the bladder appeared so remarkable to Kessler that he established the genus *Diplophysa*[2] on this character and

[1] In 1922 (*Rec. Ind. Mus.*, XXIV, p. 67), I published a figure and a short description of the bladder of *Nemachilus vittatus* and pointed out the presence of a pneumatic duct. I have now dissected a large number of specimens and find that no such structure exists.

[2] The original description of the genus *Diplophysa* is as follows:—'Corpus valde elongatum, ad finem posteriorem conspicue compressum, alepidotum; oculi, plica palpebriformi, a rostri apice atque a rimis branchialibus aeque fere remoti; ossa infraocularia parva, sine spina mobilis; os cirris sex obsitum atque cinctum duobus labiis carnosis, quorum superius plus minusve denticulatum, inferius,

described a number of species in this genus. During my recent visit to Europe I had an opportunity of examining specimens of *D. strauchii* Kessler, the logo-type, and *D. labiata* Kessler in the Zoologiches Museum der Universität, Berlin. In the absence of any material and of the original description of *Diplophysa* I had formed a wrong idea of the structure of the air-bladder of this genus and consequently in reviewing its systematic position in 1922 I attached undue importance to this structure. In view of the observations made above it seems hardly justifiable to recognize *Diplophysa* as a distinct genus from *Nemachilus* for all gradations exist between the typical bladder of *Nemachilus* and the 'double bladder' of *Diplophysa*.

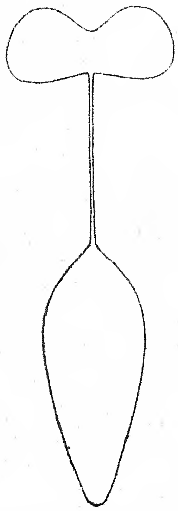


FIG. 7.—Air-bladder of *Nemachilus strauchii* (Kessler), ×2 (Diagrammatic).

All the nine species of '*Diplophysa*' described by Kessler are known to inhabit deep rivers or lakes. *D. strauchii* and *D. labiatus* are from Eastern Turkestan; *D. intermedius, D. nasalis, D. costata* and *D. dalaicus* are known from lake Dalai-nor, which is situated in the lake basin of Mongolia and *D. kungessana, D. papilloso-labiata* and *D. microphthalmus* found in the Tarim river-system which ultimately drains into Lake Lob-nor. I have shown elsewhere that the fauna of the high altitudes is in most cases derived from the neighbouring mountain streams and has become secondarily modified for life in sluggish waters. This reversion of habitat brings about a reversion in the evolution of the animal organization, but in no case does the animal develop its truly primitive characters, for the path of progression is different from that of regression.

A species of *Nemachilus* (=*Diplophysa*) showing remarkable modification of the air-bladder was described by me in 1922 from Eastern Tibet. Of this species—*N. stewarti* (Hora)—several young and half-grown specimens were collected by Capt. R. S. Kennedy and Capt. F. H. Stewart in a stream flowing into Rham-tso. The air-bladder of *N. stewarti* is as usual divided into two portions which are connected by a short and narrow tube[1], the anterior portion is bilobed and partially enclosed in bone and its two lateral chambers are connected by a short and narrow neck; the posterior portion, which lies free in the abdominal cavity, is divided into two

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bilobum, plus minusve papillosum: pseudobranchiæ absunt; vesica natatoria in duas partes, anticam, involucro osseo billobo praeditam, et posticam, elongatum, ventriculo superpositam, partita.'

'Ad genus Botia Gray proxime accedit, sed differt carente spina mobili in ossibus in infraocularibus.' Kesler, *Bull. Soc. Sci. Moscou,* XI, p. 57 (1874).

[1] In 1922, when I described this structure, I missed the connection between the two portions of the bladder, and, therefore, erroneously considered the two portions as distinct bladders.

chambers by a constriction thus assuming to a certain extent the form of a normal Cyprinoid bladder. The most remarkable point about this bladder is that it possesses a short pneumatic duct connecting the anterior end of the posterior portion of the bladder with the œsophagus. In this respect the air-bladder of *N. stewarti* has reverted to the primitive Cyprinoid condition so far as its function is concerned though structurally it is still very different.

I have yet to refer to an extremely remarkable species of *Nemachilus* described by me from the Northern Shan States, Burma. Of this species—*N. acuticephalus* Hora—I have examined only five specimens collected by Dr. J. Coggin Brown from the Hwe-gna-sang River in the Pazi Township of the Monglong Sub-division of Hsipaw State. Its rounded and tapering head, the small and compact fins and the general facies suggest that the species is adapted to a burrowing mode of life. But this is a mere assumption for no observations are available regarding its precise habitat.[1] The bladder of *N. acuticephalus* is similar to that of the Central Asiatic species of *Nemachilus* referred to above; the anterior and the posterior portions of the bladder are connected by a long and narrow tube. Outwardly there is little evidence of such a modification of the bladder and the bony walls of the capsules are fairly compact and solid. If my surmise about the habitat of this species be found correct by later investigators, the modification of its bladder could then be accounted for in this way. From the nature of the bladder there seems no doubt that the immediate ancestors of *N. acuticephalus* were inhabitants of deep waters where the bladder served as a hydrostatic organ. On taking to a burrowing mode of life the bladder is becoming reduced again. If this explanation be found correct then here we have a striking illustration of the phenomenon of reversion in evolution on a grand scale. The normal Cyprinoid bladder first became reduced in swift currents and then in the calm and placid water of deep rivers and lakes at high altitudes it regained its functional activity by undergoing a set of structural modifications. Later, on account of the burrowing habit of the species it has started to retrograde. It seems to me probable that environment is the supreme master of most of the changes in animal organization and that organic

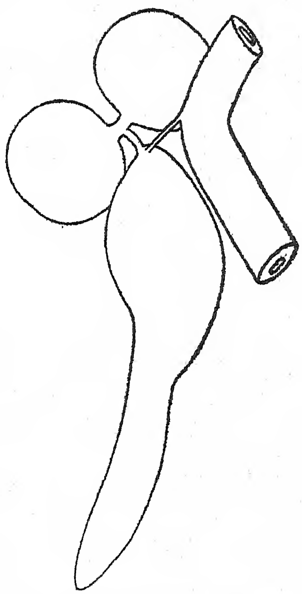

Fig. 8.—Air-bladder of *Nemachilus stewarti* (Hora), ×7½.

[1] It may be remarked here that the other species of fish obtained by Dr. J. Coggin Brown from the Hwe-gna-sang River belong to highly modified hill-stream genera.

evolution is a manifestation of the varied conditions under which life can exist.

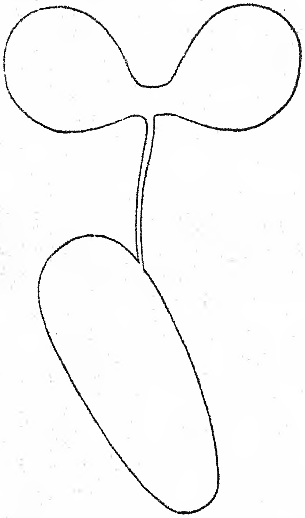

Fig. 9.—Air-bladder of *Nemachilus acuticephalus* Hora, ×15.

It has been remarked by Bridge and Haddon that the assumption of a purely ground habit of life is the most important cause that has led to the degeneracy of the air-bladder in so many forms of fishes. I have also subscribed to this view. The observations recorded above give the fullest measure of support to this hypothesis, for it is clear that as soon as a fish gives up its ground habit of life, its air-bladder begins to revert and to function as a hydrostatic organ. It seems to me probable that for a similar reason the lungs of brook-inhabiting Amphibians are reduced. Noble's recent explanation that the 'increased oxygen contents of mountain-stream water is one of the factors permitting lung reduction in Amphibia living in these waters' is true only to a very limited degree. In 1923, I made certain observations on the lungs of two tadpoles, *Rana afghana* and *Megalophrys parva*. Both are found living together in the small, torrential streams in the Khasi Hills, the former adhering to the exposed surfaces of rocks and stones in a swift current and the latter skulking under rocks or among roots of vegetation in the same place. There is no difference in temperature in the habitats of these two tadpoles and yet in *R. afghana* the lungs are small and non-functional for the entire period during which it lives in rapid waters and in the tadpoles of *M. parva* the lungs are represented by two thin-walled sacs which are distended by air-bubbles. These differences in the lung structure are correlated with the mode of life of these tadpoles. The tadpoles of *R. afghana* lead a ground habit of life and in them a pneumatic structure would have been distinctly harmful, whereas the tadpoles of *M. parva* use their lungs as hydrostatic organs when during periods of drought they are isolated in small pools and puddles.

Noble has given several instances to show that the lung reduction in the Amphibia is not confined only to torrent-inhabiting forms and has supported his contention by remarking that the air-bladder of fishes has been reduced or lost in other habitats besides the mountain brooks. This is perfectly true, but the fact should not be overlooked that wherever the reduction of the bladder, has been observed it is known that those fishes lead a ground habit of life. For instance in the mud-inhabiting Siluroids of India, such as *Clarias* and *Saccobranchus*, the air-bladder is greatly reduced and is enclosed in bony capsules. The habitat of these fishes is very different from that of the brook-inhabiting forms, yet the reduction

of the air-bladder increases the specific gravity of both kinds of fish so that they can remain near the bottom in their respective habitats. I have shown elsewhere that animals living under different conditions may be called upon to respond in similar fashion to a common factor in their habitats, which would lead independently to 'functional adaptation to similar ends' and thus result in convergence of characters. In the study of 'adaptations' there are two things to be considered, the modifications in the characters of an organism and the factors that influence its life in an environment. When the study of both of these problems goes hand in hand, there is not the least doubt we shall have satisfactory data for the study of the method of organic evolution.

The study of the characters of organisms is greatly advanced but the study of environmental factors is still in its infancy. I shall, therefore, state briefly what I mean by isolating and studying the factors in an environment. It is usually considered enough for a field collector[1] to sweep the bed of a small torrential stream with his bag-net and transfer his catch to a tube containing some alcohol and label the entire lot 'from a clear, rapid-running stream with rocky bed and little vegetation.' Such a label is obviously misleading for a brook consists of a series of rapids, falls and pools, and generally flows over a rocky bed with tufts of mosses and weeds covering rocks and stones here and there. The fauna of the pools is different from that of the rapids and, again, the animals that live on rocks in a rapid are different from those that live in the moss. In October last I subjected to a thorough investigation a small rapid in the stream below the Dumpep Dak Bungalow in the Khasi Hills. The rapid was formed by a series of small falls so that the water in falling over them sparkled and foamed and appeared like a miniature silver cascade. At the base of the rapid there was a broad basin formed by a single slab of stone over which the water rushed with considerable speed. In the rapid itself certain portions of rock were covered with moss while others were quite bare. On the bare rock only nymphs of the mayfly genus *Bætis* were found while the moss harboured a fairly rich fauna. Nymphs of Plecoptera and Ephemeroptera, larvae of *Simulium,* Chironomidæ, Trichoptera and of *Elmis*, two kinds of beetles and two kinds of bugs were found in the moss. In the basin below the rapid the substratum could be divided into three distinct regions, namely, (i) bare rock, (ii) moss-covered rock, and (iii) rock covered with tufts of the weed *Eriocaulon miserum* Kern. It may be remarked that the current was not so swift in the basin as it was in the rapid. The bare rock in the basin was inhabited by the nymphs of *Bætis* and a few *Simulium* larvae. The moss in this region harboured a richer and more varied fauna than that found in moss in the rapid. The weed *Eriocaulon* provided better shelter and substratum for a foot-hold and, consequently, it contained the richest fauna in this habitat. Lepidopterous and Coleopterous

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[1] I do not in any way want to discourage amateur collectors because their collections are extremely valuable in increasing our knowledge of the general fauna of the country.

larvae and Naucorid bugs were found among the roots of the plants; *Simulium* and Chironomid larvae were found on the exposed surfaces of leaves and stems while several kinds of nymphs of Ephemeroptera and Plecoptera, Rhyacophilid larvae of Trichoptera, Elmid beetles and a few Planarians were found entangled among the leaves and stems of plants. Thus there are three different habitats into which the fauna of these weeds can be roughly divided and the animals of each habitat are differently modified. My collection from the habitats referred to above has not been worked out yet and, therefore, I cannot go into greater details about animal adaptations here, but I hope the broad outline of the classification of habitats that I have laid before you is sufficient to show what difference the nature of the substratum alone makes in the distribution of the fauna even when all other factors remain the same. The value of field observations is the greatest in the study of animal ecology, and I do not see how it can be possible to distinguish various 'strata' in an environment by carrying out experiments, however detailed and elaborate, in a laboratory. I believe that the place of field observation in the study of evolution cannot be usurped. Experimental Zoology has its own role to play, and I do not underrate its value. In this country we have excellent opportunities in a field which is still so little explored. The late Dr. N. Annandale directed our attention to the vast opportunities open to us in the study of zoology from a biological point of view and Col. R. B. S. Sewell has impressed on us 'the paramount importance to this country of the study of Ecology and Bionomics.' He advised us to go out and study the animals in their own surroundings. A suggestion was made by Col. Sewell that one or two selected students from colleges and universities should accompany Zoological Survey parties so as to be able to study the fauna of this country in its natural surroundings under the guidance of a trained field worker. Unfortunately, no attention seems to have been paid to this generous gesture of the Director, Zoological Survey of India.

In making the above observations I do not for a moment underrate the importance of experimental physiology, embryology, morphology, taxonomy or genetics; but I sincerely believe that the most effective method of elucidating the why and wherefore of Organic Evolution is to make direct observations on the organisms and their environments. The fact should not be lost sight of that the study of the latter is as important as the sudy of the animal itself.

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THE VERNAY SCIENTIFIC SURVEY OF THE EASTERN GHATS.

ORNITHOLOGICAL SECTION.

BY

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INTRODUCTION.

In recent numbers of our Journal, the members of the Bombay Natural History Society have been informed that a scientific survey of the Eastern Ghats was contemplated, and by the time that this number of the Journal is issued from the press, the survey will actually have been made and nearly completed. Some time will necessarily lapse before the collections obtained are fully worked out and the results available for publication; but, in the meantime, the Society is anxious that a preliminary report should appear, so that members of the Society may learn somewhat of the progress of the work.

The necessity of the survey from an ornithological point of view does not require elaboration. All systematic workers at Indian Ornithology have had practical experience of the fact that their work was continually hampered in all directions by the absence of specimens and field notes from practically the whole of the Madras Presidency. The birds of the Nilgiris are fairly well known and there are a good many specimens of Nilgiri birds in the British Museum and other collections. With this local exception, it may be stated in general terms that Dr. Jerdon's old and poor specimens in the British Museum said to come from 'Madras', but with no reliable data, and Dr. Jerdon's own field notes and observations scattered through the volumes of his historic book comprise almost the whole of the material available to represent the Madras Presidency and the line of the Eastern Ghats and the low country extending up the greater part of the East Coast of India.

This deficiency has been felt throughout the whole of Indian Ornithology. It has been felt more seriously than ever since the rise of the study of local geographical races or subspecies and their expression in the trinomial system of nomenclature. That the deficiency has been so greatly felt is not surprising. As is well known, a very large number of Indian birds are widely distributed in India, Burma and Ceylon, to say nothing of often a further distribution beyond these countries. With such a wide distribution, they have been subject to greatly differing influences of climate, rainfall, soil and elevation and the effects are seen in the number of geographical races into which the majority can be shown to fall. There is now available to students of these effects of wide distribution a great mass of material in the British Museum, the Indian Museum, the Society's collection and in a number of private collections; but every student sooner or later finds his work hampered and his conclusions rendered incomplete by the absence

of material representing Madras and the Eastern Ghats. When it is remembered that in this area are situated the type localities for names of many Indian birds, and those in some cases very common ones, it will be realized that this gap in our material may often have far-reaching results.

The hope of an Ornithological Survey of South-Eastern India has therefore for a long time been in many minds. The fact that the Society has at last been able to initiate such a survey has been due to the generosity of one of its Vice-Patrons. The name of Mr. A. S. Vernay is already well-known to Ornithologists, not only in India but across the seven seas, as that of a patron to the science who combines generosity with an ample appreciation of the fields where such generosity may most advantageously be applied. And they will not be surprised therefore to learn that, when Mr. Vernay heard and appreciated the need of an Ornithological Survey of South-East India, he took steps to make it possible. To Mr. Vernay, in short, we are indebted for this present enterprise.

As soon as the survey was provided for, the Society took steps to secure the advice and co-operation of the Indian Museum at Calcutta. The result was that its scope was enlarged to include not only birds but general collecting as well. When it took the field in April 1929, the survey included the following personnel with the duties detailed against them :—

Mr. V. S. LaPersonne (in charge of the Expedition) :—Birds.

Mr. N. A. Baptista :—Mammals.

The programme for the survey was not left to chance, to be decided as the work progressed by local attractions and facilities. The Society first of all made a preliminary study of the various districts through which the Eastern Ghats range, utilizing the aid of physical maps and such data as was available in the various local *Gazetteers.* The authorities of the Indian Museum were consulted. Attention was also paid to the known geological features of the area as well as the distribution of the forest areas and the divisions of the hill ranges. The known type localities for birds described by the early naturalists were also borne in mind.

Working with this collection of data, the Society fixed on a programme of dates and camps as follows :—

1. *Salem District.*—

   Time : April, May and June (Rainfall 10″).
   Collecting camps : Plains round Pondicherry, Hills—Shevaroys.

2. *Cuddapah District.*—

   Time : July, August and September (Rainfall 15″).
   Collecting camps : Palkonda Hills.

3. *Kurnool District.*—

   Time : October–November (Rainfall 15″).
   Collecting camps :—Cumbum Valley, Nallamalai Hills.

4. *Godavari District.*—

   Time : December (Rainfall nil).
   Collecting camp : Godavari Delta.

5. *Vizagapatam District.*—
Time : January, February and March (Rainfall nil).
Collecting camp : Main Range, Trans-Ghat (Jeypore Agency).

6. *Ganjam District.*—
Time : April–May (Rainfall nil).
Collecting camps : Russelkonda Hills, Plains, Chilka Lake.

7. *Balasore, Orissa.*—
Time : June (Rainfall nil).
Collecting camps : Hills and Plains.

Up to the time of writing, this programme with small exceptions has been kept to fairly closely and on the whole has proved very satisfactory. When the Survey is complete, we shall place on record a diary of the dates and places where the survey actually worked.

The instructions given to Mr. LaPersonne to guide him in collecting birds were necessarily of a general nature only. He was warned that a good series from the different areas of common, resident birds was the chief desideratum ; that such resident birds were to be preferred to migrants from the north which were merely passage birds or winter visitors in the area and so likely to have little local significance. He was impressed with the need of careful sexing of the specimens and the desirability of recording the state of organs on the labels. He was also asked to furnish as many field notes as possible.

Since the Survey took the field in April 1929, Mr. LaPersonne has worked very carefully with these instructions in mind. He has sent back batch after batch of beautiful specimens, the numbers obtained and the standard of their preparation being all that could be desired. Considering the time at his disposal both for collecting, skinning, labelling and writing up his notes, and the fact that he was continually working in localities of which he had no previous knowledge, he is to be congratulated on doing well. The Survey is already definitely a success, and when it is complete, we may expect very real results from it.

It has not yet been possible to work out the results in detail. When the Society's Mammal Survey was initiated, our Journal was able to furnish a series of reports of great interest straightaway from the beginning. But this was because at that date the smaller mammals of India were so little known that systematic collecting in any district immediately produced a number of novelties either in the way of undescribed forms or of extensions of range or important additions to our knowledge of habits. This cannot be with the present survey. The birds of India are well known and probably few or no species remain unknown. A few geographical races perhaps remain to be discovered and described, and there is still a good deal of work to be done in reviewing the races and the distribution of many of the better known species. Such work is not spectacular ; it implies much study of the large series in the

British Museum and collation of existing literature; and with the material from South-Eastern India, which the Survey is now making available, this work can now be done more satisfactorily than ever before. It is, however, obvious that it cannot be done before the Survey is complete and the last specimen added to each series. To attempt to work out or verify the races and distribution of a common species when the first specimens come to hand from the Salem district is to risk our conclusions being upset and the work to be done anew when the series from the other collecting camps is before us.

We are sure therefore the members of the Society will recognize the need for patience. The specimens are being identified, measured and catalogued as they reach the British Museum. Notes are accumulating on the interesting points that arise from them. Then, when the Survey is complete, each species will be examined afresh and the detailed report written, making, we hope, a substantial contribution to the Ornithology of India.

In the meantime, in order to give some idea of the manner in which the work is proceeding, we have written a short account of the material collected at the first camp in the Salem district. This report shows the number of specimens obtained of each species and the collector's notes on their abundance or otherwise. The identifications are provisional, pending revision when the Survey material is complete. For this reason we have often omitted the trinomial. The notes of some of the early naturalists who collected or received specimens from this part of India will be of more than local interest. They furnish, incidentally, examples of the haphazard way in which chance has fixed the type localities of many species and races—a chance, which, crystallized by the rigid application of the Law of Priority of Nomenclature, often acts as a definite obstacle to a satisfactory classification of the local races of a species.

With these preliminary remarks, we set before our members a brief report from the first collecting camp.

REPORT I.

Kurumbapatti, Salem District.

April 9th to May 6th, 1929.

Kurumbapatti is about 12 miles from Salem town, and about half a mile from the southern foot of the Shevaroy Hills. The members of the Survey reached Kurumbapatti on the 8th April, 1929, and, by the courtesy of the officers of the Forest Department, were allowed to put up in the Forest bungalow in the Kurumbapatti Forest Reserve which made an ideal collecting ground. Large tracts of secondary jungle occur within a mile radius of the bungalow, and practically the whole area between Salem town and the foot of the Shevaroys is covered with this jungle. The whole area is dry—in fact, to quote Mr. LaPersonne's words—' it would almost seem as if the drier portion of the Kanara forests were lifted *en bloc* and placed here.'

Kurumbapatti Forest Reserve is considered secondary jungle from the point of view of the Forest Department. Bamboo grows throughout the area, but it is not big enough to be of much commercial value. The remainder of the Reserve is either 'Korunda' or large tracts of cactus and low scrub.

Large trees are few and chiefly tamarind, banyan or babul. Except for a small patch on which Kurumbapatti village stands, the soil is red. Open patches occur in the jungle either naturally or cleared by the forest people. Bird life is varied and plentiful, but scarcity of water, the paucity of open grazing and the attentions of local shikaris have had a bad effect on game animals. Mr. LaPersonne had hoped to work the southern slopes of the Shevaroys from this camp, but the jungle proved to be almost impenetrable.

Collecting here was carried on under very pleasant conditions so far as temperature was concerned. There was rain every evening which kept the days cool, and heavy rain fell on five consecutive days from the 24th to the 29th April. Continual mist and heavy clouds could be seen shrouding the Shevaroys.

At this camp 197 birds were collected and a detailed list of them now follows:—The specimens obtained are enumerated under each species. All were collected at Kurumbapatti and its immediate neighbourhood.

The Jungle Crow. Corvus coronoides culminatus Sykes.

Corvus culminatus Sykes. P.Z.S., 1832, p. 96 (Deccan).—Common throughout the district both in villages and in the jungle. Birds carrying twigs noted on 23rd April (V. S. LaP.).

The correct treatment of the Jungle Crows of India is still a matter requiring further consideration. There are two main points at issue. First of all, opinions differ as to whether they should be regarded as races of one widely spread species occurring throughout the whole of South-Eastern Asia, with the exception of a few islands, from the mouth of the Amur to Turkestan, south to Ceylon and Tasmania and east to New Britain. In this case the oldest specific name for the whole group is *coronoides*, the name given in 1826 by Vigors and Horsfield to a crow from near Sydney. This type is in the British Museum. The other view is that the crows of the area should be regarded as falling into two species, each with its own races. Under this view *coronoides* remains the name for the Australian forms, whilst our Indian races are attributed to a separate species *levaillanti* of which the type comes from Java.

In India we are concerned with a second problem, the number of races to be recognized and their correct names. The new edition of the *Fauna* recognizes four races as follows:—

Corvus coronoides levaillanti, Lesson. Traité d'Orn., p. 328 (1831—Bengal)
,, ,, *culminatus*, Sykes. P. Z. S., 1832, p. 96 (Deccan).
,, ,, *intermedius*, Adams. P. Z. S., 1859, p. 171 (Kashmir).
,, ,, *andamanensis*, Tytler. Beavan, Ibis, 1866, p. 420 (Port Blair, Andamans).

These races are probably correct, so long as one recognizes the fact that in the intermediate areas individuals cannot be definitely assigned to one or other race. Meinertzhagen (*Nov. Zool.*, xxxiii, 1926, p. 83) has, however, raised the theory that *culminatus* cannot stand for the South Indian and Singhalese race. His argument is that the type specimen is abnormally small and evidently a dwarf and that all other specimens from the Deccan are far larger and clearly belong to the race *levaillanti* so that *culminatus* becomes a synonym of that name. Whether his view is correct or not should be settled as our survey progresses northwards to the area which lies along the south of Bengal down towards the Deccan, and it is hoped that the Society's collectors will pay special attention in this area to the procuring of a very carefully sexed series of this crow.

Should Meinertzhagen's view be correct, *Corvus coronoides* (*levaillanti*) *anthracinus* (Madarasz). Ann. Mus. Nat. Hungar., 8, 1911, p. 420. (Ceylon) becomes the correct name for the small crow of South India and Ceylon to which our specimen clearly belongs. The measurements of all these races of Jungle Crow within our limits require to be worked out *de novo* based on carefully sexed specimens known to be in their breeding area. Average measurements including both sexes and possible migrants are valueless.

Among the early writers on Indian birds the name of Col. W. H. Sykes stands out prominently. His natural history studies were not confined to birds, but he also collected mammals and fishes and contributed papers on them to the Zoological Society. He took an interest in Geology and wrote a long paper on the Geology of the Deccan for the *Indian Review*.

Col. Sykes was born in 1790 and went out to India in 1803, receiving a commission in the Bombay Army on May, 1 1804. He saw a good deal of service during the Mahratta wars, commanding his regiment at the battles of Kirkee and Poona and took part in the capture of many of the numerous hill forts along the Western Ghats.

In 1820 he went on furlough to England and after spending four years at home returned to India in 1824 when he was seconded from military duty and appointed Statistical Reporter to the Government of Bombay.

He held this post till December 1829, when it was abolished on the score of expense. Sykes, however, offered—should he be relieved of military service—to complete his report gratuitously. This offer, to the shame of the Bombay Government, was accepted and Sykes continued to work at his report till January 1831, when he finally returned to England. In the following year he published in the *P. Z. S.* his well-known paper 'A Catalogue of the Birds of the Deccan.'

His specimens on which this paper was based were presented to the H. E. I. Coy.'s Museum and, when that collection was broken up, passed to the British Museum where they are now.

The country where Sykes collected his birds consists of the following districts:—The whole of the Poona, Sholapur and Satara, the eastern part of Bijapur and Ahmednagar, and the southern part of Nasik.

The House-Crow. Corvus splendens Vieillot.

Corvus splendens Vieillot, Nouv. Dict. d' Hist. Nat., viii, 1817, p. 44
V 185 ♀ 4-5-29 ; V 186, 4-5-29.

Common in Salem Town but does not enter the jungles here. Specimens obtained were that from a party which evidenty halted here on their way to the Shevaroys. The whole flock flew off over the outer ridge of the Shevaroys. From their genital organs, it would seem that they do not breed until late in June. (V. S. LaP.).

The Indian Tree-Pie. Dendrocitta rufa (Latham)

Corvus rufus Latham, Ind. Ornith., p. 161 (1790—Malabar coast).

V. 82 ♂ 18-4-29. A very worn and bleached specimen

Common though scattered over the area. Specimens in moult, but others were observed mating. Birds in full 'song'. No other species of *Dendrocitta* observed. (V.S. Lap.).

There is some divergence of opinion about the races of this species in our Limits. The *Fauna* gives the following races :—

Dendrocitta rufa (Latham) loc. cit.
,, *vagabunda*—Latham. *Index Orn.*, p. 171 (1790—India restricted to Calcutta).
,, *sclateri*—Stuart Baker, *F.B.I.*, 2nd ed. i., 50 (1922—Mr. Victoria).
,, *kinneari*— Do. do. do. p. 51 (1922—Toungoo).
,, *saturatior*—Ticehurst, *Bull. B.O.C.*, xlii, 56 (1922—Kaukareyat, Amherst).

Ticehurst, however, who has carefully examined this group (*Ibis*, 1922, 537) does not consider *sclateri* and *kinneari* worthy of separation but does recognize *pallida* [Blyth, *J.A.S.B.*, xv. 1846, p. 30 (Simla)] as a larger, paler race from the North-WestHimalaya, Sind, Rajputana, Punjab, North-West Frontier. While suspending final judgment until the survey is complete, we are inclined to think that neither treatment of the group is satisfactory and that a regrouping of the races is required.

Latham's name *Corvus rufus* is based on the description and plate of 'La Pie rouse de la Chine' in Sonnerat's '*Voyage aux Indes Orientales et la Chine*' pl. 106, p. 186.

This bird was said to have come from China, but as the species is not found further east than Indo-China, there must have been some mistake and on that account Baker has fixed 'Malabar' as the type locality.

Piérre Sonnerat was a French naturalist and traveller who was born at Lyons in 1745 and died in Paris in 1814. He made two voyages to the East, but the second was the one which he described in the above-mentioned work. He set out in 1774 and after visiting Ceylon proceeded to the coast of Malabar where he stayed at Mahé. After making excursions in the Ghats, he sailed up the coast to Surat and from there proceeded to the Coromandel Coast where he remained for some time and then went to the Malay Peninsula and China. He later returned to South India and for two years travelled through the province 'du Carnate, du Tanjaeur et du Madure.'

His explorations were interrupted by the outbreak of war with Great Britain and he was in Pondicherry when that town was besieged, and on its surrender he returned to France. He died in Paris in 1814.

The Jungle Babbler. Turdoides terricolor (Hodgson).

Pastor terricolor Hodgs., J.A.S. B., v, p. 771 (1836—Nepal).

V. 10 ♀ 10-4-29; V. 25♂ 11-4-29; V. 35 ♂ 12-4-29; V. 56 ♀ 15-4-29. V. 130 ♂ 26-4-29; V. 135, 26-4-29.

A bird of the denser portions of the Reserve. There is no intermingling with the next species which is more a bird of the neighbourhood of villages. (V. S. LaP.).

There is such complete intergrading between the races of this bird that it is difficult to define their distribution. We hope to discuss the point in detail when the Survey is complete.

The White-headed Babbler. Turdoides polioplocamus Oberholser.

Turdoides striatus polioplocamus Oberh., Proc. Biol. Soc. Wash., 33, p. 84 (1920—Carnatic).

V. 3. ♀ 9-4-29; V. 24 ♂ 11-4-29; V. 34 ♂ 12-4-29;
V. 90 ♂ 19-4-29; V. 93, V. 97 ♂ ♀ 20-4-29; V. 110, 22-4-29;
V. 131-134 ♂ ♀ ♂ ♂ 26-4-29.

A common and confiding bird met with both in dense jungle and villages. It may often be met with round the forest bungalows, particularly about the kitchen. (V. S. LaP.).

We have kept this name as a binomial for the present as we are not yet satisfied with regard to the exact relationship between the Singhalese bird *Turdoides striatus* (Swains.) and these two continental species of Babbler.

Horsfield's Scimilar-Babbler. Pomatorhinus horsfieldi Sykes.

Pomatorhinus horsfieldi Sykes, P.Z.S., 1832, p. 89 (Deccan).

V. 122 ♂ 24-4-29; V. 140-142 ♂ ♂ ♀ 27-4-29.

Neither seen nor heard before April 24th. That night there was very heavy rain which continued for four or five days, during which period I heard the call incessantly. (V. S. LaP.).

This is another species whose named races intergrade so completely throughout its range that it is almost impossible to define the races or ranges.

The White-throated Babbler. Dumetia albigularis (Blyth).

Malacocercus albigularis Blyth, J.A.S.B., XVI, p. 453 (1847—Tapoor Pass).

V. 37-39 ♂ ♂ ♂ 13-4-29; V. 49 ♂ 14-4-29; V. 107 ♀ 22-4-29;
V. 137-138 ♂ ♂ 27-4-29; V. 56-157 ♂ 0 ? 30-4-29.

These birds are all just completing an entire moult, and the organs are either undeveloped or only of moderate size.

Common and met with practically wherever there are hedges and sparse jungle (V. S. LaP.). This and *D. hyperythra* should probably be considered as races of one species.

Described from a specimen collected by Dr. T. C. Jerdon at the top of the Tapoor Pass near Jaulnah.

The Yellow-eyed Babbler. Pyctorhis sinensis (Gmel.).

Parus sinensis Gmel., Syst. Nat., I, p. 1012 (1789—China).

V. 65 ♂ 16-4-29; V. 106 ♂ 22-4-29; V. 193-194 ♂ ♂ 6-5-29.

V. 148 O ? 28-4-29.

A bird of hedges and sparse jungle. Not common and extremely shy. Breeding; though specimens are still in moult. Inside of mouth black; orbital skin and legs yellow or lemon-yellow. (V. S. LaP.).

It seems curious, though there is apparently no doubt of the fact, that the Chinese and Indian birds are not separable. There is however some conflict of opinion as to what races should be recognized in our area.

The new edition of the *Fauna* recognizes the following forms :—

Pyctorhis sinensis sinensis (Gmel.).

,, *saturatior*, Ticehurst, *Bull. B.O.C.*, xlii; p. 57 (1922—Bhutan Duars).

,, *nasalis*, Legge, *Ann. Mag., N. H.*, (5) iii, p. 169 (1879—Ceylon).

Ticehurst, however, in his examination of the group (*Ibis* 1922, 542) considers that Franklin's name *hypoleucus* (*P.Z.S.*, 1831, 118) should be restricted to the United Provinces and used for a paler race extending from Sind, North-West Frontier Province and the Punjab to the United Provinces, Khandesh and Kathiawar. We hope that a good series of this common bird will come in from the Survey and help us to decide between these divergent views.

Latham in his *General Synopsis of Birds*, vol. ii, pt. 2, pp. 555, 783 first described this bird from drawings in the possession of Capt. Broadley and said it came from China, but he proposed no Latin name which was done later by Gmelin.

The Spotted Babbler. Pellorneum ruficeps Swainson.

Pellorneum ruficeps Swainson, F. Bor.-Am., Birds, p. 487 (1831—Nilgiris).

V. 86 ♀ 19-4-29; V. 118–119 ♀ ♂ 24-4-29; V. 183–184 ♀ ♂ 4-5-29.

From their organs it was evident that the birds were soon to breed.

Not quite common, but possibly the birds were more common than they appeared, owing to their skulking habits and the thickness of the undergrowth. One was seen carrying nest material on April 17th (S. V. LaP.).

The above series appear to be indistinguishable from Nilgiri birds. Harrington originally confined his dark race *granti* to Travancore and we are not certain that the *Fauna* is right in attributing to it also the birds from Coorg, the Wynaad and South-West Mysore. A fine series of this species is coming in from some of the later collecting camps and it should be possible later on to speak more positively of the distribution of the races of this common bird.

The Common Iora. Ægithina tiphia (L.)

Motacilla tiphia Linnæus, Syst. Nat., ed X., p. 186 (1758—Bengal).

V. 18-19 ♂ ♀ 11-4-29; V. 42 ♀ 13-4-29; V. 77 ♀ 18-4-29;

V. 99-101 ♂♂♂ 21-4-29; V. 189-190 ♂♂ 5-5-29.

Common throughout the district of Salem, ascending the hills to 4,000 ft. Specimens vary in density of blackness on the upper parts. Breeding from April to June. (V. S. LaP.).

The above males are all in full breeding plumage.

The nestling stage of this common bird is quite unknown and we would urge the necessity of obtaining specimens in spirits in the hope that an examination of the down plumage (if any) may throw some light on its affinities.

Linné took his description of the Common Iora from the figure and descriptions in part ii, p. 79, plate 79 of George Edward's *Natural History of Birds* (1747), where it is called 'the Green Indian Flycatcher' and came, we are told, 'with others from Bengal' to Mr. Joseph Dandridge.

Of this Mr. Dandridge we know very little except that he lived in London at Stoke Newington and was a pattern drawer in Moorfields by trade. He was greatly interested in different branches of Natural History and had collections of birds, lepidoptera and fungi. Of the first he had both eggs and specimens, either stuffed or 'preserved dry', as well as a number of drawings. He corresponded with John Ray in regard to his insects and many of the well-known botanists of the day about his fungi.

Dandridge first allowed Albin to draw his birds and then, not being satisfied with the results, induced Edwards to make paintings of them also, certainly with better results.

Jerdon's Chloropsis. Chloropsis jerdoni (Blyth).

Phyllornis jerdoni Blyth. J.A.S.B., vol. xiii, p. 392 (1844—Goomsoor) V. 98 ♂ Imm. 20-4-29; V. 187 ♂ ad. 5-5-29.

No. V. 98 is a most interesting specimen in female dress with a body moult into the adult male plumage just commencing. The position and affinities of the genus and the peculiar distribution of the various species are clearly not fully understood and their investigation may be commended to Ornithological members of the Society. It is particularly desirable to obtain chicks in spirit and skins exhibiting the juvenile plumages and the various moults.

The name *jerdoni* was proposed by Blyth for the bird identified by Jerdon as *cochinensis* in his Catalogue No. 247 which he said he had obtained at Goomsoor, the Tapoor pass and elsewhere. The first named place which is in the north of Ganjam may be considered the restricted type locality.

The Red-vented Bulbul. Molpastes hæmorrhous (Gmel.).

Muscicapa hæmorrhous, Gmelin. Syst. Nat. i, 941 (1789—Ceylon). V. 50 ♂ 14-4-29; V. 53 ♀ 14-4-29; V. 116 ♂ 23-4-29.

Common and breeding throughout the district. Hard set eggs found on 23rd April. (V. S. LaP.).

The name *Muscicapa hæmorrhous* was given by Gmelin to the bulbul from Ceylon figured by Peter Brown in his *New Illustration of Zoology*, published in 1776. This work contained fifty illustrations of mammals, birds, reptiles and insects which were accompanied by descriptions in French and English and a number of the figures of birds were copied from a collection of paintings belonging to Governor Loten.

John Gideon Loten was the Dutch Governor of Ceylon from 1752 to 1757 when he was transferred to Batavia. While in the East he employed an artist to make paintings of different objects of Natural History, and, when he retired in 1758, he brought these paintings with him to Holland.

A few years ago the British Museum was fortunate enough to acquire this collections of drawings which consists of 101 sheets of birds, 5 of mammals, 10 of insects, 14 of fishes, etc., and 14 of plants, and represents species found in Ceylon, Java and other Islands of the Indian Archipelago which belonged to the Dutch.

Some of these drawings were, as we have noted, copied by Peter Brown while others were used by Pennant and Forster in the different editions of the *Indian Zoology*.

The Southern Red-whiskered Bulbul. Otocompsa emeria fuscicaudata Gould.

Otocompsa fuscicaudata Gould, P.Z.S., 1865, p. 664 (Madras). V. 70-72-73. ♀ ♂♂ 17-4-29; V. 152 ♂ 29-4-29.

Common but not quite so plentiful as *M. hæmorrhous*. Breeding in hedges. (V. S. LaP.).

The White-browed Bulbul. Pycnonotus luteolus (Lesson).

Hæmatornis luteolus Lesson, Rev. Zool. p. 354 (1840—India, Bombay). V. 11 ♀ 10-4-29; V. 79 ♀ 18-4-29; V. 165 ♀ 1-5-29.

Extremely common in jungle and village hedges. I do not think there is a space of ten square yards that does not harbour this bird.

He has a lively, rowdy chatter with no attempt at harmony—just a burst of not unpleasing notes, ending in a frightened whistle They are busy at present chasing each other round, but I have not observed any signs of nest building. The organs of the above are slightly developed. (V. S. LaP.).

The above birds agree with the topotype from Bombay. When the Survey series is complete and full measurements are available for the two sexes, it will be necessary to settle the question as to the validity of a supposed smaller race in Ceylon.

The Southern Pied Bush-chat. Saxicola caprata atrata (Blyth.).

Pratincola atrata Blyth, J.A.S.B., xx, p. 177 (1851—Ceylon) V. 8 ♂ 9-4-29; V. 164 ♂ 30-4-29.

Only two specimens were seen in and around the village here, both males with well developed testes. (V. S. LaP.).

Dr. Kelaart, who sent this bird to Blyth, under the above name but did not himself describe it, was born in Ceylon in 1860. His father was a 'burgher' of Dutch descent employed in the Military Medical department. At an early age young Kelaart was sent to England to study medicine and surgery and, after taking his diploma, was appointed Staff Assistant Surgeon to the troops stationed at Gibraltar. While there he occupied himself with studying Marine

Zoology and in making a collection of the plants found in British territory, an account of which he published under the title *Flora Calpineses*. Later, he was transferred to the Ceylon Medical Service and there busied himself in his leisure time with the study of the fauna of the island. On account of ill-health, he was ordered to England in 1860 and died at sea on the way on August 31st at the age of forty-two. Kelaart was a regular correspondent of Blyth's and though he did not himself shoot, he procured many interesting and new specimens of birds and mammals from others. Most of his specimens were obtained in the vicinity of Newara Elia.

He is best known by his *Prodromus Fauna* published in 1852 in which the accounts of mammals and reptiles are much superior to that on the birds. For the latter he relied to a very great extent on the work of E. L. Layard and unfortunately published his list without that Ornithologist first revising it.

The Black-backed Indian Robin. Saxicoloides fulicata (L.).

Motacilla fulicata Linnæus, Syst. Nat. vol. i, p. 336 (1766—Philippines in error, Ceylon). V. i, ♀ 9-4-29; V. 31 ♂ 12-4-29; V. 153 ♂ 29-4-29.

Common in open patches and around villages. One chick seen in a nest on April 15 (V. S. LaP.).

The Magpie Robin. Copsychus saularis (L.).

Gracula saularis Linnæus, Syst. Nat., X, p. 109 (1758—Bengal). V. 71, ♂ 17-4-29.

Abundant, met with alike in forest and open secondary jungle. (V. S. LaP.).

This name was given by Linné to the bird figured and described by Edwards as 'the Little Indian Pye' (*Birds*, pt. iv, p. 181, pl. 181). Both sexes were described, but only the male figured 'They were sent from Bengal, preserved dry, to the late Mr. Joseph Dandridge of Moorfields, London', Edwards tells us, and adds that the sender called them 'Dyals.' Albin also depicted this species and called it the Bengal Magpie, while Petiver in Ray's *Synopsis Methodica Avium et Piscum*, p. 197, pl. 2 Nos. 19 and 20, calls them cock and hen Saularies.

The Indian Shama. Kittacincla malabarica (Scop.).

Muscicapa malabarica Scopoli, Del, Flora et. Fauna Insubr. II, p. 96 (1786—Mahé).

V. 29 ♂ 11-4-29; V. 33 ♂ 12-4-29; V. 109 ♀ 27-4-29.

From the organs the above birds appeared about to breed.

Richmond has pointed out (*Proc. U. S. Nat. Mus.*, XXVI, 1903, p. 152) that Scopoli gave the above name to Sonnerat's 'Les Gobe-mouches á longue queque de Gingi' (*Voy. Aux. Ind. etc.*, p. 196) and by mistake refers also to plate III which is a drongo, but the description is quite clear and the name must stand. Sonnerat, though he writes 'Lè Gobe-mouche etc-de Gingi' states that the bird came from the Malabar Coast and so the neighbourhood of Mahé must stand as the type locality.

Tickell's Blue Flycatcher. Cyornis tickelliæ Blyth.

Cyornis tickelliæ Blyth, J. A. S. B., xii, 941 (1843—Borabhum, Central India).

V. 22-23 ♀ ♂ 11-4-29; V. 115 ♂ 23-4-29; V. 149 ♀ 28-4-29; V. 170 ♂ 2-5-29.

Not common. Breeding in jungle. Organs developed. (V.S. LaP.).

Col. S. R. Tickell who collected the specimen described by Blyth went out to India in 1829 when he was appointed to the 31st Bengal Native Infantry.

In 1834 he passed into civil employ and served for some years as Political Assistant, S. W. Frontier, i.e., the S. W. Frontier of the Bengal Presidency of these days.

He was greatly interested in Natural History and in 1833 published a paper in volume ii of the Asiatic Soc. of Bengal entitled 'A list of the Birds collected in the Jungles of Barabhum and Dhalbhum'. In this article he gives notes on fifty-four different species of birds, thirty-six of which he described as new.

His paper 'On the Ornithology of India: A description of the eggs, also nests of several birds of the plains of India collected chiefly during 1845-46' which appeared in the *Asiatic Society's Journal*, vol. xvii (1848) was the first account of the eggs of Indian birds' eggs nesting in the plains.

In 1847 he was transferred to Arakan and served in Burma for the rest of his service. He died in 1875.

The Paradise Flycatcher. Terpsiphone paradisi paradisi (L.).

Corvus paradisi Linnæus, Syst. Nat., ed. x, p. 107 (1758—Fort Saint George, Madras).

V. 30 ♂ 12-4-29 ; V. 36 ♂ 12-4-29 ; V. 60 ♀ 15-4-29.

V. 125 ♂ 25-4-29.

The organs of the birds were scarcely developed.

The first reference quoted by Linné is that of Ray in *Synopsis Methodica Avium et Piscum* published in 1713. In this work there is an account illustrated by Petiver of some birds from Madras founded on pictures and descriptions sent him by Dr. Edward Bulkley.

The drawings are crude woodcuts, but certain of the species—especially the Pied Bird of Paradise as it is called—are easily identified.

Dr. Bulkley was a surgeon in the East India Company's employ at Madras and went out there in 1692. He was appointed to take charge of the hospital and held various other medical appointments till 1709, when he resigned on account of ill-health. In the same year he was appointed to the Company's local Council and served as member of Council and Paymaster till 1713, when he had again to resign on account of health and shortly afterwards died.

Bulkley was said to be a man of great ability and energy and did much to improve the hospital and medical arrangements in Madras.

He appears to have been interested in Natural History and sent plants and insects to Petiver, besides the drawings above referred to.

The Black-naped Flycatcher. Hypothymis azurea sykesi S. B.

Hypothymis azurea sykesi Stuart Baker. Bull. B. O. C., xl, p. 6 (1920—Deccan).

V. 55 ♂ 15-4-29 ; V. 66 ♀ 16-4-29 ; V. 96 ♂ 20-4-29.

V. 121 ♀ 24-4-29 ; V. 163 ♂ 1-5-29.

Not very common. Met with in thick jungle, particularly in shady nullahs overhung by lofty trees. (V. S. LaP.).

The White-spotted Fantail Flycatcher. Rhipidura pectoralis (Jerdon).

Leucocerca pectoralis Jerdon, iii, Ind. Orn. Text to pl. ii, (1847—Nilgiris).

V. 108 ♀ 22-4-29 ; V. 195 ♂ 6-5-29.

Not common and met with only in dense jungle. (V. S. LaP.).

Jerdon in his catalogue of the Birds of the Peninsula of India published in the *Madras Jour. Litt. and Sci.* (1839-44) mentions under the head of *Leucocirca fuscoventris* (Frankl.) that he had seen a fantail flycatcher in the Nilgiris but had been unable to obtain a specimen. When visiting these hills some years later, he obtained specimens and found the bird was a new species and named it as above.

The Bay-backed Shrike. Lanius vittatus Valenc.

Lanius vittatus Valenc., Dict. Sci. Nat., xl, p. 227 (1826—Pondicherry).

V. 102 ♂ 21-4-29 ; V. III—112 ♀ ♂ 22-4-29.

Both males are remarkable for the extent of the black forehead and its contrast with a practically white patch behind it.

The type of this shrike was collected by M. Leschenault de la Tour, a French naturalist and traveller, born in 1773. He visited India in 1816, remaining some time at Pondicherry and then travelling up the line of the Ghauts to Bengal from where he went to Ceylon returning to France in 1822. In the following year he visited South America. He died in Paris in 1826.

The Southern Grey-backed Shrike. Lanius schach caniceps Blyth.

Lanius caniceps Blyth, J. A. S. B., xv, 302 (1846—Madras).

Not common. Specimens were shot in cactus-covered country and were certainly breeding in the vicinity. (V. S. LaP.).

When describing their species in the *Journal of the Asiatic Society*, Blyth, had, according to his catalogue, examples from (1) Rajmahal, (2) Sind and (3) South India. As (1) and (2) are presumably *erythronotus*, the northern form, the bird from South India must be the type. It was presented by D. Ross and came from the vicinty of Madras.

The Brown Shrike. Lanius cristatus cristatus Linnæus.

Lanius cristatus Linnæus, Syst. Nat., ed. x, p. 93 (1758—Bengal).

V. 12 ♀ 10-4-29 ; V. 32 ♀ 12-4-29 ; V. 103 ♂ 21-4-29 ; V. 139 ♂ 27-4-29.

The organs are undeveloped in the above birds and three of them are undergoing a complete moult, contrary to the statement in the *Fauna* that all the shrikes have only an autumn moult. The distribution given there that in winter this shrike is found practically throughout Northern India as far south as Mt. Abu on the west and Orissa on the east is incorrect. It is not found in the Punjab, the N. W. F. Province or Sindh, but, to quote Oates, it is a winter visitor to the whole of the Empire except that portion lying to the west of a line roughly drawn from the Sutlej Valley to Mount Abu ; Ceylon ; the Andamans.

The specimen Linné took his description from was a young example, with cross bars still on the breast, figured by Edwards in his *Nat. Hist. Birds*, p. 54, pl. 54 and called the Crested Red or Russet Butcher bird. It was sent to Dandridge from Bengal.

The Common Wood-Shrike. Tephrodornis pondiceriana (Gmel.)

Muscicapa pondiceriana Gmelin, Syst. Nat. i, p. 939 (1789—Pondicherry).
V. 89 ♀ 19-4-29 ; V. 178-179 ♀ ♂ 3-5-29.

It is evident from the organs of these birds that the breeding season was beginning.

Gmelin took his description from Sonnerat's 'Les gobe-mouches de Pondicherry' ; *Voy. aux Ind. Orient. et la Chine*, p. 198, 17.

The Small Minivet. Pericrocotus peregrinus (Linnæus).

Parus peregrinus Linn., Syst. Nat., i, p. 342 (1766—Umbala).
V. 113-114 ♂ ♀ 23-4-29.

Both specimens had the organ well advanced. Others were seen always in pairs (V. S. LaP.).

We are not yet satisfied as to the necessity for the changing of the well-established name of this species to *cinnamomeus* (vide *Bull. B. O. C.*, xlix, p. 63). This point and the question of races we propose to discuss later when the survey material is complete.

The Black-headed Cuckoo-Shrike. Lalage sykesi Strickland.

Lalage sykesi Strickland. Annals Mag. Nat. Hist., (1) xiii, p. 36 (1344—Calcutta).
V. 196 ♀ 6-5-29.

In complete moult, more than one specimen was observed but only one secured. Birds were seen to mate on April 27. Not very common though during the first week in May, their numbers increased (V. S. LaP.).

The Large Cuckoo-Shrike. Grauculus macei Lesson.

Grauculus macei Lesson, Traité, p. 349 (1831—Bengal).

More or less common though not in pairs. Identified with field-glasses, but no specimens procured (V. S. LaP.).

The Ashy Swallow-Shrike. Artamus fuscus Vieillot.

Artamus fuscus Vieill., Nouv. Dict. d' Hist. Nat., xvii, p. 297 (1817—Bengal)
V. 173 ♀ 2-5-29.

The only specimen seen but it apparently had flying young. (V. S. LaP.). The chick in spirit of this bird is badly needed for examination.

The King-Crow. Dicrurus macrocercus Vieillot.

Dicrurus macrocercus Vieillot, Nouv. Dict. d' Hist. Nat., ix. p. 588 (1817—India, restricted to Orissa.) V. 94 ♀ 20-4-29.

Common and breeding all over the area. Nest with eggs seen on April 9. (V. S. LaP.).

It is hoped that the Survey will get a good series of King Crows of any species which are known to be on their breeding ground. Until carefully sexed series are available of such birds, it will be impossible to disentangle races of these birds. Measurements which do not distinguish the sexes and which probably include local birds and migrants from elsewhere are quite valueless. At present many of the species of this group must be considered to be in confusion.

The Ashy Drongo. Dicrurus leucophæus Vieillot.

Dicrurus leucophæus Vieillot, Dict. d' Hist. Nat. Nouv., ed. ix, p. 587 (1817--Java) V. 74 ♀ 17-4-29.

This is another species of the genus which appears to be still in confusion and the collectors require to obtain as much further material as possible.

The White-bellied Drongo. Dicrurus cœrulescens (Linnæus).

Lanius cœrulescens Linn., Syst. Nat., ed. xii, p. 134 (1766—Bengal). V. 2, ♀ 9-4-29; V. 57 ♂ 15-4-29; V. 175 ♂ 3-5-29.

Common all over the area. Nest with 2 young seen in May. (V. S. LaP.)

The connection between the White-bellied Drongos of India and Ceylon is still obscure and requires working out fresh.

The Large Racket-tailed Drongo. Dissemurus paradiseus (Linnæus).

Cuculus paradiseus Linnæus, Syst. Nat., ed. xii, p. 172 (1766—Siam).

No specimens secured. Birds are not common and keep well in the thickest jungles. (V.S.LaP.).

Brisson in his *Ornithologie*, vol. iv, 1760, p. 151, pl. 14, gave a figure and described this bird from a drawing of a live bird made by M.D. Poivre.

Blyth's Reed-Warbler. Acrocephalus dumetorum Blyth.

Acrocephalus dumetorum Blyth, J. A. S. B., xviii, 815 (1849—India) V. 17 ♀ 11-4-29; V. 40-41 ♀♀ 13-4-29; V. 69 ♀ 17-4-29; V. 159 ♂ 3-4-29.

Strickland pointed out to Blyth that '*Calamoherpe montana* of India is not the same as Horsfield's *montana*, in which the wing is 2 in. long, graduated; the 5th quill longest' and on that account the Indian bird required a new name. Blyth therefore gave it the name as above.

The Indian Tailor-Bird. Orthotomus sutorius (Pennant).

Motacilla sutoria Pennant, Ind. Zool., p. 7 (1769-Ceylon). V. 46-48 ♀ ♂♂ 14-4-29; V. 62-63 ♀ ♀ 16-4-29; V. 84 ♂ 19-4-29; V. 88 ♀ 19-4-29; V. 120 ♀ 24-4-29.

Common in bamboo forest and secondary jungle (V.S. LaP.).

Pennant, not Forster as given in the second edition of the *Fauna*, described the Tailor Bird in 1769.

After Governor Loten returned from the East he came to London and there met Thomas Pennant, the author of *British Zoology* and a great correspondent of Gilbert White's. He showed him his collection of paintings and Pennant suggested that they should be published in a book to be called *Indian Zoology* for which he would write the letterpress and the cost of reproducing the plates would be paid for by Sir Joseph Banks, Loten and himself.

This arrangement did not work well and the book was brought out before all the plates were reproduced. Pennant then suggested that J. R. Forster, a German naturalist at the time in England, who had accompanied Cook on his second voyage, should be given the remainder of the plates and asked to bring out another edition. This was agreed to and Forster returned to Germany taking with him three unpublished plates. In 1781 Forster published his *Zoologia Indica or Indesche Zoologie*, in German and Latin. It contained the same plates as Pennant's edition together with three extra ones.

Franklin's Wren-Warbler. Franklinia gracilis (Franklin).

Prinia gracilis Franklin, P. Z. S., 1831, p. 119 (Vindhyani Hills). V. 52 ♂ 4-4-29.

Major James Franklin, who described this species, was an officer in the 1st Bengal Cavalry and was a very keen geologist. He made several expeditions into different parts of the Central and United Provinces for the purpose of investigating the rocks and studying their stratification.

In the end of 1828, or early in 1829, he set out from Calcutta and proceeded by boat up the Ganges to Monghyr where he arrived on January 14th. He had been specially requested by the Asiatic Society to collect birds, and by the time he reached Monghyr, he was able to report to the Society that he had secured forty specimens along the banks of the river. Continuing up the Ganges as far as Mirzapur, he then left the river and proceeded southwards to the Tons valley thence westwards *via* Semaria, Hatta, Sohawal and Narsingarh to Saugor. From there he went S. E. to Deori, and the Bhanner Hills to Jubbulpore where he arrived on July 12th. Some two hundred birds were collected, which he handed over to the Society, who in turn presented them to the Zoological Society.

Franklin must have collected carefully, as his collection included the Chestnut-bellied Nuthatch, Spotted Tree-Creeper and Franklin's Nightjar and, in addition to the skins, he had made coloured drawings of all the birds while fresh. These drawings were exhibited along with the skins before the Zoological Society in September 1830, but now appear to have disappeared.

Franklin fully described his collection in the *Proceedings of the Zoological Society* for 1831 and there enumerated 156 species, of which thirty he described as new.

The Greenish Willow-Warbler. Phylloscopus nitidus viridanus Blyth.

Phylloscopus viridanus Blyth, J.A.S.B., xii, 967 (1843—Calcutta) V. 12 ♀ 10-4-29; V. 76 ♂ 17-4-29; V. 161 ♀ 1-5-29.

Extremely fat and probably on migration (V. S. LaP.). The above specimens show that this species undergoes a complete spring moult in April.

The Large Crowned Willow-Warbler. Phylloscopus occipitalis occipitalis (Blyth).

Phyllopneuste occipitalis Blyth. J. A. S. B., xiv, p. 593 (1845—Nellore) V. 54 ♂ 1-5-29.

Very fat and also probably on migration.

Blyth said that the bird he described was sent to him from S. India by Dr. Jerdon and according to the latter's *Birds of India*, vol. i, p. 196, the bird came from Nellore.

The Ashy Wren-Warbler. Prinia socialis Sykes.

Prinia socialis Sykes. P.Z.S., 1832, p. 89 (Deccan). V. 64 O ? 16-4-29; V. 136 ♂ 26-4-29; V. 145-147 ♂ ♀ 28-4-29. Shot in the open jungle. Do not enter dense forest. (V. S. LaP.).

The Jungle Wren-Warbler. Prinia sylvatica Jerdon.

Prinia sylvatica Jerdon, *Madras Jour. L. S.*, xi, p. 4 (1840—Seegar, Nilgiris) V. 87 ♂ 19-4-29.

The Indian Wren-Warbler. Prinia inornata Sykes.

Pinia inornata Sykes. P. Z. S., 1832, p. 89 (Deccan). V. 162 ♀ 1-5-29.

The races of all these species of Wren-Warbler appear to require revision and it is hoped that the Survey will obtain sufficient material for this to be possible.

The Black-headed Oriole. Oriolus xanthornus (Linnæus).

Coracias xanthornus Linn., Syst. Nat., ed. x, p 108 (1758—Bengal). Specimens observed through field glasses but none obtained. (V. S. LaP.).

Linné based his description on the Black-headed Icterus from Bengal in Edward's *Birds*, pt. ii, p. 77, pl. 17.

The Black-headed Mynah. Temenuchus pagodarum (Gmel).

Turdus pagodarum Gmelin, Syst. Nat. i, p. 816 (1789—Malabar). V. 83 ♀ 18-4-29; V. 158 ♂ 30-4-29.

Solitary pairs observed feeding round villages (V.S. LaP.).

The Baya Weaver. Ploceus philippinus (Linnæus).

Loxia philippina Linn. Syst. Nat., ed. xii, i, p. 305 (1766—Ceylon). V. 26 ♀ V. 28 ♂ 11-4-29; V. 150 ♂ 28-4-29; V. 166-168 ♂♀♀ 1-5-29.

All the males are in very fresh eclipse plumage with no sign of moult. Common and going about in large flocks of 20 to 30 individuals. Specimens as early as 11th April show increase in size of testes and latterly they showed more development. Still in large flocks on 6th May. (V. S. LaP.).

The survey should pay particular attention to these weavers as it is evident that their status and movements, their plumages, and their races are not yet fully understood.

Linné gives the type locality as the Philippines, but in this he had been misled by Brisson who gave a description of this Weaver in his *Ornithologie*, stating that the specimen he had seen was from these islands in the collection of M. L'Abbé Aubry. No true *Ploceus* inhabits the Philippines and the description agrees with bird inhabiting South India and Ceylon.

The White-backed Munia. Uroloncha striata (Linnæus).

Loxia striata Linnæus, Syst. Nat., ed. xiii, p. 306 (1766—Ceylon). Specimens seen but none secured. Towards the end of April, I noticed a total absence of these birds and they had apparently left the neighbourhood. (V. S. LaP.).

The Common Rosefinch. Carpodacus erythrinus roseatus (Hodgson).

Erythrospiza? roseata Blyth J. A. S. B., 1842, p. 461 (Calcutta). V. 171–2 ♀ ♂ 2-5-29.

Shot feeding on the figs of a Banyan tree. Extremely fat and with the organs quite undeveloped. (V. S. LaP.).

The Madras Bush-Lark. Mirafra assamica affinis Jerdon.

Mirafra affinis Jerdon, Madr. Jour. Lit. Sci., xiii, pt. 2, p. 136 (1844–45 Goomsor in Gangam. V. 7 ♂ 9–4–29 ; V. 9 ♀ 18–4–29 ; V. 43 ♂ 13–4–29 ; V. 61 ♀ 16–4–29 ; V. 75 ♂ 17–4–29 ; V. 123 ♀ 24–4–29 ; V. 126 ♀ 25–4–29.

Fairly common in open patches though I have met them in the jungles where they nest most probably. The soil on which they were living (sample kept) appears to be a mixture of red and cotton soil. The above specimens were in varying degrees of genital development. (V. S. LaP.).

Loten's Purple Sunbird. Cinnyris lotenia (Linnæus.).

Certhia lotenia Linnæus, Syst. Nat., 12th ed., i, p. 188 (1766—Ceylon). V. 21 ♀ 11-4-29 ; V. 83 A, V. 85 ♀♀ 19–4–29 ; V. 151 ♂ 29–4–29.

Sunbirds in general were common throughout the jungle tracts. (V. S. LaP.).

The huge beak of this species is very noticeable and the measurements given for it in the new edition of the *Fauna* are far too small. Linné's description is based on a drawing or actual specimen of the bird sent to him by J. C. Loten, which he had obtained while in Ceylon as Governor.

The Purple-rumped Sunbird. Cinnyris zeylonica (Linnæus).

Certhia zeylonica Linnæus, Syst. Nat., 12th ed., i, p. 181 (1766—Ceylon). V. 20 ♂ 11-4-29 ; V. 67 ♂ 16–4–29 ; V. 146 ♂ 28–4–29 ; V. 176 ♀ 3–5–29.

Special attention will have to be paid to this sunbird as the Survey moves northward as its range is very imperfectly known up the east side of India.

This bird like the last was received by Linné from J. G. Loten.

The Indian Pitta. Pitta brachyura (Linnæus).

Corvus brachyurus Linn., Syst. Nat., ed. xii, i, p. 158 (176—Ceylon). V. 15 ♂ 11–4–29 ; V. 27 ♀ 11–4–29 ; V. 68 ♂ 16–4–29.

Common and breeding throughout Kurumbapatti Forest area in dense forest. (V. S. LaP.).

The account in the *Fauna* of this bird which is described as a resident rather obscures the real position. Amongst those species which are confined to the Indian Empire, it is one of the most marked migrants moving from north to south in the autumn passage and *vice versa* in spring in vast multitudes. Long ago Jerdon described the way that exhausted birds on passage took refuge in bungalows and outhouses.

Linné took his description from Edwards's Short-tailed Pye (*Gleanings in Natural History*, p. 242, pl. 324). This bird had been figured already by Albin, and Edwards is very scathing of his picture and writes 'Albin has figured this bird from a bad drawing done in India, which I have seen at Mr. Dandridge's, though Albin would have the world believe his draught was from Nature.'

The specimen figured came from Ceylon and was presented by Governor Loten to the British Museum.

The Yellow-fronted Pied Woodpecker. Leiopicius mahrattensis (Latham).

Picus mahrattensis Latham, Ind. Orn. Supp., p. xxxi (1801—Belgaum). V. 191–192 ♂♂ 6–5–29.

In pairs. Not plentiful. (V. S. LaP.).

Originally described from a specimen in the British Museum from the Mahratta country. The specimen is no longer in existence.

Pygmy Woodpecker. Yungipicus hardwickii hardwickii (Jerdon.).

Picus hardwickii, Jerdon, Mad. Jour. Litt. and Sci., xiii, p 138, 1844 (Wynaad-Baker.).

V. 128. ♂ 25-4-29.

We have provisionally listed this specimen as *hardwickii*, but when further material is available, we think there will have to be some alterations in regard to the names of these woodpeckers.

The Golden-backed Woodpecker. Brachypternus benghalensis puncticollis (Malherbe)

Brachypternus puncticollis Malherbe, Rev. Zool., 1845, p. 405 (Nilgiris).

V. 129 ♀ 25-4-29 ; V. 154 ♂ 29-4-29.

Fairly common though spread over a wide area (V. S. LaP.).

This is another of the common and widespread species of India of which the races appear to require further consideration.

Malherbe in his original description says the bird he described came from the Nilgiris and not Ceylon as given in the second edition of the *Fauna*.

The Common Hawk-Cuckoo. Hierococcyx varius (Vahl).

Cuculus varius Vahl, Skriv. Nat. Selsk., iv., p. 61 (1797—Tranquebar).

V. 78 ♀ 18-4-29 ; V. 143 ♂ 27-4-29.

Quite common and heard throughout the day and part of the night. The female secured was about to lay. The gizzard contained 'beetles, ants, crickets and one large spider.' (V. S. LaP.).

The Pied-crested Cuckoo. Clamator jacobinus taprobanus Hartert.

Clamator jacobinus taprobanus Hartert, Nov. Zool., xxiii, p. 254 (1915—Ceylon).

V. 95 ♀ 20-4-29 ; V. 105 ♂ 21-4-29 ; V. 127 ♂ 25-4-29 ; V. 155 ♂ 29-4-29.

The earliest specimen secured was on April 20th, and from that date they seemed to increase in numbers. By the first week in May, all parts of the jungle had a pair of these birds : at least so it seemed from their noisy courting. (V. S. LaP.).

The above series is of considerable interest. All are in rather worn plumage without any sign of moult and on the label of the female, the collector has noted that she was laying eggs. From their small size the birds evidently belong to the small southern race, originally described from Ceylon and it is noteworthy that they arrived in the Salem District and commenced breeding about two months before a larger race is accustomed to arrive and breed in Northern India. It will be remembered that in a recent number of the *Journal*, our members were asked to collaborate in working out the migrations of this Cuckoo, and this evidence tends to support the theory that the winter quarters of the typical form are not in South India, and therefore probably in Africa.

The Small Green-billed Malkoha. Rhopodytes viridirostris (Jerdon).

Zanclostomus viridirostris Jerdon, Madras Jour. Lit. Sci., xi, p. 223 (1840—Coonoor).

V. 58-59 ♂ ♀ 15-4-29.

Common and breeding in Kurumbapatti Forest Reserve (V. S. LaP.).

The Blossom-headed Parrakeet. Psittacula cyanocephala (Linnæus).

Psittacus cyanocephalus Linn., Syst. Nat., i, p. 141, No. 10 (1766—India Orientali—Gingee).

V. 4 ♂ 9-4-29.

This parrakeet was described from the description given by Brisson in vol. iv, p. 343, of his *Ornithologie* published in 1766. In this work the letter-press is in Latin and French. The bird is said to have been in the collection of M. L'Abbe Aubry and to have come from 'Gingiuiano Regno in India Orientale,' i.e. Gingee in the South Arcot District.

The Little Green Bee-eater. Merops orientalis Latham.

Merops orientalis Latham, Ind. Orn. Suppl., pl. xxxiii (1801—Mahratta country).

V. 173 ♀ 2-5-29.

Fairly common. Birds were incubating on my arrival on 9th April. A nest was located in an old stone wall. (V. S. LaP.).

The Common Grey Hornbill. Lophoceros birostris (Scopoli).

Buceros birostris Scop., Del. Flor. et Faun. Insubr., ii, p. 87 (1786—Coromandel).

Several seen and they appear to be breeding. No specimens secured.

They are extremely shy, most probably on account of being slaughtered for food by the local shikaris. (V. S. LaP.).

The Palm-Swift. Tachornis batasiensis (J. E. Gray).

Cypselus batasiensis J. E. Gray in Griff. An. Kingd., ii, p. 60 (1829—India, Calcutta).

V. 5 ♂; V. ♀ 9-4-29.

Appear to be common. (V. S. LaP.).

The Spotted Owlet. Athene brama (Temminck).

Strix brama Temminck. Pl. Col., pt. 68, (1823—Pondicherry).

V. 51 ♀ 14-4-29.

A single specimen secured. Birds were heard in the forest. (V. S. LaP.).

The Southern Green Pigeon. Crocopus phœnicopterus chlorogaster (Blyth).

Vinago chlorogaster Blyth, J. A. S. B., xii, pt. i, p. 167 (1843—Indian Peninsula).

V. 144 ♂ 28-4-29.

Not common here. (V. S. LaP.).

The Imperial Green Pigeon. Muscadivora ænea pusilla (Blyth).

Carpophaga pusilla Blyth, J. A. S. B., xviii, p. 816 (1849—Nilgiris).

V. 14 ♀ 10-4-29.

Ovaries slightly developed. Not common. Shot from a party of four. (V. S. LaP.).

The reference to this bird in the *Fauna*, 2nd edition, is wrong. It was described by Blyth in 1849 (not 1840) and the bird came from the Nilgiris—obtained by Jerdon—not Ceylon.

The Spotted Dove. Streptopelia chinensis suratensis (Gmelin).

Columba suratensis Gmel., Syst. Nat., i, p. 778 (1789—Surat).

V. 160 ♀—5-29.

Fairly common (V. S. LaP.).

This is another of Sonnerat's birds described and figured by him in *Voy. aux Ind. Orient. et à la Chine*, plate p. 179, but like the rest of his discoveries not named in Latin.

The Grey Jungle-Fowl. Gallus sonneratii Temminck.

Gallus sonneratii Temm., Pig. et Gall., ii, p. 246 (1813—India).

V. 16 ♀ 10-4-29.

Fairly well distributed over the Reserve. Female with young observed on May 2nd. (V. S. LaP.).

The Red Spur-Fowl. Galloperdix spadicea (Gmelin).

Tetrao spadicea Gmelin, Syst. Nat., i, pt. 2, p. 759 (1789—Nilgiris).

V. 44 ♀ 13-4-29; V. 81 ♂ 18-4-29.

More or less common. (V. S. LaP.).

Gmelin's name is founded on Sonnerat's *Perdix Rouge de Madagascar* (*Voy. aux Indes, etc.*, p. 169) but the bird like others had probably been introduced into Madagascar by the French.

Common Bustard-Quail. Turnix suscitator taijoor (Sykes).

Hemipodius taijoor Sykes, P.Z.S., 1832, p. 155 (Deccan).

V. 80 ♀ 18-4-29.

This female had a fully formed egg in the oviduct.

The Indian Button-quail. Turnix maculatus tanki Blyth.

Turnix tanki Blyth, J.A.S.B., xii, p. 180 (1843—India).

V. 45 ♂ 13-4-29.

Mr. LaPersonne states that *Turnix* generally was common.

Blyth's description and name were based on Buchanan-Hamilton's MS. named drawing of a bird from Bengal.

The Indian Stone Curlew. Burhinus œdicnemus indicus (Salvad.).

Œdicnemus indicus Salvadori, Atti. Soc. Ital. Sci. Nat., viii, p. 381 (1866—India).

V. 117 ♀ 23-4-29.

Not common. A female shot had a full yolk in the ovary. Breed in open scrub covered country or jungle. I have flushed a bird in thick bamboo clump. (V. S. LaP.)

The Red-wattled Lapwing. Lobivanellus indicus indicus (Bodd).

Tringa indica Bodd, Pl. Enl. p. 50 (1783—Goa.).

V. 92 ♀ 19-4-29.

(*To be continued*)

THE HABITS OF MILLIPEDES

(*MARPTODESMUS SP.*)

BY

MAJOR R. W. G. HINGSTON, I.M.S.

(*With two illustrations*)

The monsoon has come. Black banks of cumuli cross the heavens. An unceasing torrent pours upon the plains. From time to time a lull occurs and the sunlight streams through a dispersing mist. Then we see signs of the coming animation, of the life that is being reborn on earth. The air begins to ring with the chorus of frogs; a bright clamour fills the voices of the birds. The coppersmith tolls a louder clang. It is scarcely dawn when the cuckoos cry, some with a pleasing attractive voice, others with a maddening note. A little later in the morning comes the cooing of the doves, and the clarion voice of the oriole pouring forth its liquid sounds. Insects too are coming into life. Indeed their business has already begun. Ants are re-storing their inundated tunnels; dung-beetles have already started on their pellets: termites are preparing for their nuptial flights. A thousand little creatures, not seen before, are now starting on the business of life. On every side is noise and bustle, the voice of expectation and the thrill of work aroused by these animating rains.

This is the time to look for our millipedes. When the sun shines forth after the very first torrent we are likely to see them creeping on the soil. The one I refer to is a species of *Marptodesmus*. It belongs to the Order *Chilignatha,* a division of the Myriapod group. It is one of those creatures often misnamed. Sometimes one hears it called a wireworm. Indeed the name Millipede is equally inaccurate, for it means a creature with a thousand legs.

Everyone knows it, the hard red worm-like creature, about an inch and a quarter long. Its body is smooth, in shape cylindrical, and divided into rings or segments, each with a transverse bar. Its small head has well-formed antennæ; the rest of its body has a multitude of legs. These latter are mere tags of appendages, arranged in a double line. The millipede's body is highly flexible: it can easily twist itself into a coil.

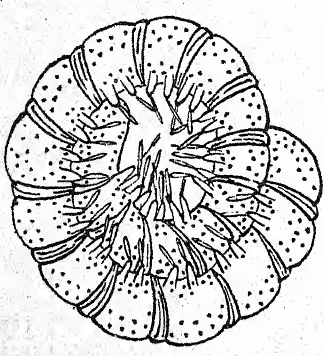

FIG. 1.—Millipede coiled.

Its mode of progression is well worth notice, particularly the undulating movement of its legs. There are two pairs of legs on each segment, and the

two pairs work at the same time. But the legs of any one ring do not move simultaneously with the legs of adjoining rings. The line works in a longitudinal sequence. First the legs on the hind ring move; this is followed by those on the ring next in front, then by those of the next ring, and so on along the whole line. In this way the tags vibrate successively. There is progression from ring to ring, and a wave of filamentous ripples flows along the double line.

The millipede's crawl is slightly vermicular, with body extended full length. Anywhere and everywhere they are likely to be found, in gardens, on paths, on grassy plains; but they seem to prefer open patches where the earth is hard and bare. Though at first we may suspect them of being harmful, yet in reality they are perfectly innocent. They have no poison, no weapons, and they live on vegetable food. In this they differ from their allies, the centipedes, which are formidable, predaceous creatures armed with poison and fangs.

These millipedes are protected by a fluid secretion. It is evil smelling, of an acid nature, and highly distasteful to insects and birds. I have never seen an enemy attacking them, though they crawl about freely exposed. Sometimes they manage to climb a tree-trunk and lodge themselves in a decaying hole. On such a journey they are very conspicuous, yet they seem as safe as when on the ground. The armies of tree-ants which destroy everything, just touch them and pass on. There is little doubt that the millipedes are protected by their repulsive smell.

Very soon after the millipedes appear, they separate off in pairs. The female is very active. With quivering antennæ and sinuous movements she runs energetically over the ground. Harnessed full length on her back is the male. His antennæ are motionless; he rests passive, holding on with his taggy legs. The male is somewhat smaller than the female, rather more slender and a little shorter. In consequence the female is not completely covered. Her head and tail project just a little when the two are united at full length.

Life now becomes a sexual orgy. The male sometimes slowly unseats himself, and then they wander about alone. But this is a somewhat unusual occurrence, nor is it more than a temporary separation, for soon they manage to join up again. At other times they stretch themselves full length on the soil, or they twist themselves into a double spiral, one wrapped evenly round the other in two encircling coils. For weeks they remain in this united state. I see them joined all through the rains. Indeed it is unusual to see a millipede by itself. Even when they burrow they refuse to disunite; the female goes on shuffling up soil with her partner still in his place. When alarmed, they may separate, but soon they reunite. I flood them with water, but they do not come apart. I immerse them completely. They squirm about, but the nuptial combination persists. Not till they are on the point of drowning do the sexes break apart. I cut a pair transversely in half. The heads cling together; so do the tails. Even under this destructive mutilation they will not immediately come apart. It seems odd that

after egg-laying the alliance persists. Indeed their lives are little else than one endless nuptial rite. They live together: they crawl together: they dig together: united they coil themselves spiral on spiral; nothing but force can tear them apart. What excellent material do they not give us for a moral on human affairs!

But wait. Let us see the effect of experiment. I put three pairs of millipedes in a box. Each of the three females has a male harnessed on her back. I mark one pair, male and female separately, with a small speck of paint on the flank. I then leave them to their own resources. They explore their prison, wander all over it, always, of course, in united pairs. I leave them for twenty-fours, and look to them again on the following evening. I see what I expect, the six millipedes still in the box in three united pairs. But what do I observe? A new distribution has taken place. A marked male is on an unmarked female: a marked female carries an unmarked male.

I repeat the experiment and put others in the box. I mark them, separate them, and watch to see in what way they will select their mates. What do they do? Do they take again their previous partners? Is there indication of constancy in their behaviour? Not the slightest! They certainly unite as quickly as they can. But the union takes place without selection. Union and nothing but union matters. There is no choice, no constancy. One sex placidly accepts the other sex; any male or any female will do.

We refrain, therefore, from drawing a moral. For this is nothing but an animal orgy, just a blind impulsive passion for sex.

Let us now follow them into the field. The male and female, firmly united, search about for food. They nibble at vegetation, fallen fruits, and bits of decaying leaves. But they are not the strictest vegetarians. I have seen them chewing at a dead locust and eating the droppings of birds. On this nourishment the female thrives and swells with a mass of eggs. Laying takes place all through the rains, but I suspect that their fertility is highest soon after the monsoon begins. To observe the act I put the millipedes in a cage; but they do not like the unnatural confinement and resent it by scattering their eggs. However, I get some idea of their operations; and, though I could never see the whole process, yet an incident here and an incident there tells me that their method is something like this.

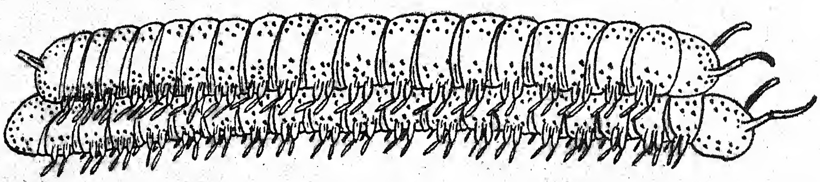

FIG. 2.—Millipedes in union.

The female, with the male still harnessed to her, digs a tunnel into the soil. Very slowly she rakes out earth, thrusting it behind

her with her tag-like legs, and worming herself into the ground. The tunnel is an oblique shaft into which she disappears from view. Having got underneath, she makes a chamber. The ones in my cage were very imperfect. But those in the field must be more carefully excavated: no doubt the architect shapes it with her mandibles and cements it with her salivery juice. Into the cavity she puts her eggs. Then I suspect, though I have not seen it, that she closes the entrance with earth. Having done this, she wanders off. Her duties to the brood are finished, and she leaves them to the safety of the soil.

The eggs are mere tiny specks, hard, firm, smooth. They are massed in clusters, hundreds in a bunch, which looks like a pinch of bright red sand. Development follows at a great rate. I keep watch on some that are scattered through the cage. Ten days after the laying I see hundreds of youngsters crawling about. They are one-sixteenth of an inch long, and look like miniatures of the adults. They are, however, distinctly paler, indeed little more than a light yellow. Nor is this pigment firmly fixed; for some which I placed in spirit were bleached pure white. On their integument are some stiffish hairs, a marked difference from the adults which are absolutely smooth. Moreover, they seem to have only six pairs of legs, a much simpler arrangement than the crowd of appendages which appear in the full grown state. It was wonderful to see how well they climbed. In the cage they scattered themselves everywhere, some alone, others in small parties, like a multitude of wriggling points. It was clear that they liked to hide under leaves; others got down into clefts in the earth. In sheltered places they made dense heaps. Even at this earliest stage they showed a strong gregarious instinct, which later we will see is the solid union on which the safety of the brood depends.

Let us follow their development in the open field. All through the rains the young are on the soil. Day by day fresh batches appear, the youngsters burrowing up by their own efforts, through narrow cylindrical shafts. The family at first remains close to its burrows. Its social instinct is very strong. The whole brood keeps together, resting on the ground in a flattened heap. The mass of millipedes is very congested: there may be hundreds or even thousands in it, all lying with bodies bent and shuffling about in the soil. They are industriously digging and rooting, seeking for bits of vegetable refuse, their first mouthfuls of food. In the heap they rest on top of one another, those on top are very restless seeking about for some bare spot into which to thrust their greedy jaws. To find one they must come to the outskirts of the heap where they fix themselves and begin to feed.

Though all in a family stick to one another, yet separate communities may combine to make a heap. Thus sizes and ages get intermingled: it is the social instinct that binds them rather than any family link. I drive some from one heap on to another heap. They are acceptable and accepted; it matters nothing that the family is different provided they are a heap. In the early mornings I sometimes see them in dense balls fixed to blades of grass. In this way, no doubt, they pass the night clinging to the vegetation in

compact lumps. In a few places they have chewed the leaves, so that they must get some nourishment from sap. But they do not like these elevated places on the vegetation. I blow on a cluster. It breaks asunder; each little millipede loosens its hold; the solid lump in a moment disintegrates and falls like a shower of rain to the earth. There for a moment they remain still; then crawl quietly away.

Now this millipede heap is a real commune; all its members are in close touch. There must be some reason for so strong an instinct. Might it not be better for the millipedes to scatter and escape competition and the scramble for food? Let us investigate the matter carefully. Can we find a reason for this social bond? I begin by touching a few of the millipedes, just gently with the tip of a straw. They get alarmed and run into the middle of the heap. They communicate their fears to others in the mass, the danger signal rapidly spreads, and soon the quiet congregation of millipedes becomes a scrambling swarm. Just by a mere tactile communication the feeling of danger has been spread amongst all the members of the common heap. Being alarmed, they try to escape. The whole body gets on the move, all climbing one over the other in a seething multitudinous flow. I now bring the straw to the opposite side, that is, I oppose the advancing stream. Again they are alarmed. The mass turns, and the millipedes, heaping themselves higher and higher, roll back like a recoiling wave.

Thus we find that these very young millipedes have the power both to spread the news of danger and to tell the direction from which danger comes. It reminds us of the same capacity amongst ants. But in a sense the act is more perfect with millipedes. Touch an ant at the edge of a swarm. It gets alarmed and the excitement spreads. All in the swarm dash about wildly; for a time the greatest confusion exists. It is quite different with the millipedes. They do not break into violent excitement. They spread the news of danger quietly, and all move away from the danger point in a steady uniform stream.

Frequently the mass moves on its own accord, probably in search of food. It is wonderful to see the heap in motion, a solid, wriggling, squirming multitude, advancing steadily in one direction as though in obedience to a word of command. The vanguard may be densely crowded, perhaps three or four layers in depth; yet it forges steadily onward followed by a straggling line.

Let us now see the advantage to the millipedes of their congregating in a heap. Each little millipede is distasteful. Even in this early stage it gives out a pungent unpleasant smell. It does not do so when resting quietly. I put my nose to the heap; there is no odour so long as it remains undisturbed. I then disturb them, and almost instantly gey a sniff of the distinctive fumes. I crush a few, and find that their macerated bodies have an acid aromatic taste. It is this pungency that protects the millipedes. I give them to some red ants, but the ants will not touch them. I have never seen a bird go near them, though such large conspicuous masses must attract every eye. Indeed their very appearance is repulsive, which suggests that they are creatures one had better avoid.

But this protection is of little value to individuals separated from the heap. I have noticed that single individuals are liable to be carried off by ants. But ants will not invade the heap; they will take only a straggler by the way. This gives the clue to the purpose of the heap. The odour given out by each millipede is feeble; it will not protect the individual millipede, but will protect them when collected in a mass. The millipedes, by congregating, strengthen their defences. The faint odours of a crowd of individuals combine to form a powerful smell. Thus combination gives them immunity at this early stage of life. As they develop their odour increases until it becomes sufficient to protect them as individuals; then the gregarious instinct disappears.

Another occurrence, also with a meaning, is seen when one blows on the heap. The millipedes are sensitive to the puff of air. But they do not rush away. This is a danger that is dealt with differently. Each little millipede becomes a spiral and lies motionless on the ground. There they remain, lying flat, thousands of perfect coils. I cease to blow. The millipedes uncoil themselves, and the crowd hurries away. Now, what is the meaning? Why do they run when touched with a straw, and coil in a puff of wind? Because by this means they get better protection. The millipedes come out in the monsoon season, a time of intermittent storm. They have little power to cling to things, and are easily scattered by wind. Also, since they like exposed places, open paths, bare patches of soil, they might often be swept away in storms. But dispersal would be fatal to them. The heap must keep intact. Hence the plan of escaping the wind by coiling. The millipedes twist themselves into the smallest size, offer the least resistance to the wind, and then lie flat on the soil.

The millipedes, even at this early stage, have their special senses well developed. They seem to have little power of vision; they can scarcely observe an object even when brought close up to their eyes. Nor is their sense of hearing acute. I fired a gun six inches from the heap without alarming them in the slightest. It is obvious from their power to communicate that they possess a good sense of touch. I made some of the usual experiments. A drop of eucalyptus at the edge of the heap resulted in the millipedes drawing away from it. I put on them some anise seed oil, and the whole community scrambled off. In the middle of the heap I placed a lump of camphor, also a nodule of earth. They drew away from the camphor and left a clear ring around it; they took no notice of the earth. These experiments, and others like them, prove the possession of an olfactory sense. I dropped some quinine solution on the heap. From the spots where it fell the millipedes withdrew. They refuse to feed where the quinine had fallen which shows that they have a sense of taste.

By the end of July the young millipedes have reached full size. The heaps then disintegrate and the sexes pair off. A sexual orgy again develops like the one we saw at the commencement of the rains. In August fresh broods of eggs are deposited, and early in September more batches of young creep about on the bare soil.

I have little else worth telling about them. Unity at every stage;

this is the guiding feature of their lives. The eggs united in a solid cluster; the young massed in a scrambling heap; the adults joined in nuptial union inseparable to the end. And at every stage this union has a purpose. In the eggs it prevents the cluster scattering; to the young it gives protection; it is probably of value to the parents since they have to propagate so large a swarm. Nature does nothing without a purpose. In this millipede union, whether social or sexual, exists their safety and strength.

APHIDIDAE OF MYSORE.

BY

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(*With 13 text figures.*)

The following is a further contribution to the knowledge of the *Aphididæ* of Mysore, of which an account of several species appeared in this *Journal*,[1] in September 1928. In this paper, are recorded for the first time interesting features of several other common forms and, of six new species of aphids, described by F. V. Theobald (of Agricultural College, Wye, Kent), in the *Entomologist* (Vol. LXII, 1929) to whom my acknowledgments are due. Parts of descriptions and complete microscopical preparations of the new and common species of aphids were furnished by me from the Entomological Laboratories of the Mysore, Department of Agriculture.

Macrosiphum eleusinæ sp. nov.

Alate viviparous female.—Head, mesothorax and antennae brown, sometimes the tip of the antennae pale; segments I and II of antennae, prothorax, cauda and tibia pale; cornicles brown; femora brown; abdomen brownish-yellow; lateral margins marked with squarish brown patches, a big polygonal brown patch also present in the centre of the abdomen; eyes red. Antennae longer than body; segment I twice as long as II; IV and V about equal; VI a little more than twice V; III with 12 sensoria on one side. Rostrum reaches 2nd coxae. Cornicles narrow, a small reticulate area at apices; cornicle as long as antennal segment III. Cauda a little less than ½ the cornicles; acuminate; two hairs each side. Length, 1, 7 to 2 mm.

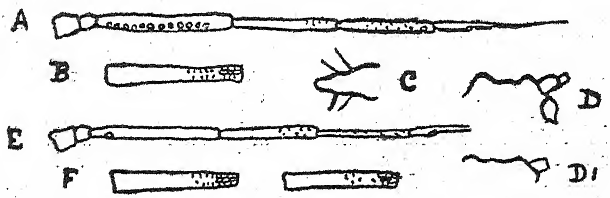


FIG. 1.—*Macrosiphum eleusinæ*, sp. nov. *A–D*, alate; *DI–F*, apterous; *A* and *E*, antennae; *B* and *F* cornicles; *C*, cauda; *D* and *DI*, head.

Apterous viviparous female.—Brownish yellow; more yellowish along the margins; antennal segments III, IV and V ringed with brown; VI all brownish; cornicles and cauda pale. Antennae longer than the body; segment I twice as long as II; III a little longer than IV, and IV equal to or slightly longer than V; VI more than twice V; cornicles as long as antennal segment IV, cylindrical, but slightly irregular in form; apex with faint reticulation, this area being small, remainder faintly imbricate. Cauda acuminate, with two pale hairs each side; about ½ the length of the cornicles; the third antennal segment has one sensorium near the base. Legs moderately long and rather thin, a few hairs on tibiae. Length, 1·7 mm.

[1] *Jour., Bom. Nat. Hist. Soc., Vol. XXXIII, No. 1,* p. 211.

Food-plant.—*Eleusina coracana* (Ragi).
Locality.—Bangalore.

Specimens collected on *Andropogon pertusus* from the same locality are, I feel sure, the same species, in spite of the different colour variations: 'Apterae, body entirely light green; antennae, cornicles and tarsi dark green; body covered with a light meal.' I can trace no structural differences from the specimens on Eleusina.

Longicaudus hamelii, sp. nov.

Alate viviparous female.—Head and eyes brownish; prothorax pale brown; mesothorax dark; abdomen yellowish brown; first pair of femora pale brown, the others dark; abdomen with black patches along the lateral margins;

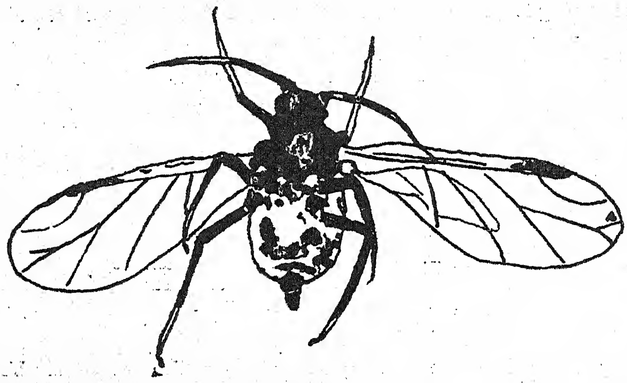


FIG. 2.—*Longicaudus hamelii*, sp. nov.

antennae, cornicles and tip of cauda brownish black. Head flat; antennae shorter than body; cornicles very small; cauda large and long; mid tibiae slightly, hind not curved. Antennal segment I wider and a little longer than II; III long, with 10-14 round sensoria in a line along one side; IV a little shorter than V; VI with base not quite half V; flagellum not equal to III. Rostrum reaches 3rd coxae. Eyes large. Cornicles short, thick, cylindrical, somewhat irregular in shape. Cauda long, with very blunt rounded apex; almost parallel sided, with 3 hairs each side, markedly outstanding. Anal plate deep, semi-oval. Second fork-cell small, length, 1·3 to 1·5 mm.

Apterous viviparous female.—Same colour as the alate female. Antennae a little shorter than the body; segments I and II about equal; III longer than IV; IV a little longer than V; base of VI about half to a little less than flagellum. Eyes moderate. Cornicles short, thick, about as long as segments I and

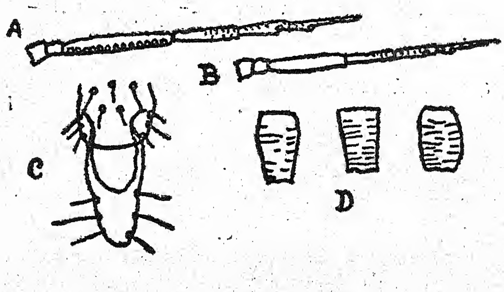


FIG. 3.—*Longicaudus hamelii*, sp. nov. *A* and *C*, antenna and cauda of alate; *B*, antenna of apterous; *D*, cornicles.

II to a little longer; cauda similar in shape to that of alate ♀ about three times length of cornicles. Legs rather thick; mid tibiae very slightly curved; hind pair very much curved; with numerous short hairs. Length, 1·4 to 1·6 mm.

Food plant.—Hamelia patens.

Locality.—Bangalore.

Easily demarked by the long, thick cauda with its 6 outstanding hairs, the curved hind tibiae in the apterae and the peculiarly shaped anal plate.

FIG. 4.—*Hyalopterus carii*, sp. nov.

Hyalopterus carii, sp. nov.

Apterous viviparous female.—Yellowish green; body with a slightly mottled appearance; tips of the antennae, legs, cornicles and the rostrum dark; eyes red, oval; antennae short, less than ½ length of body; segment I much wider than II, III longest, longer than VI and a little longer than IV and V; IV and V about equal or IV a little the longer; base of VI as long as, to a little longer than V; flagellum about ½ longer than base; VI darkened; III to IV imbricate. Head flat to slightly rounded, broad with a few short hairs. Rostrum reaches to 2nd coxae, rather broad. Cornicles short and thick, conical, about as long as hind tarsus; in some slightly constricted at apex; imbrication faint. Cauda broad, not quite twice as long as the cornicles, constricted near the middle; two hairs each side, one dorso-apical and a small third one on one side. Body with hexagonal sculpturing. Legs moderately long and narrow; tibiae with

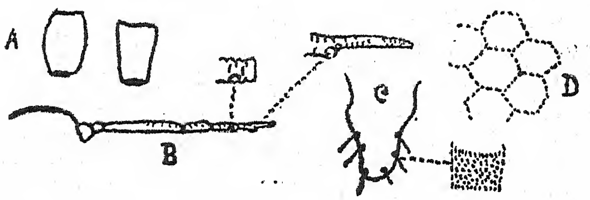


FIG. 5.—*Hyalopterus carii*, sp. nov. Apterous viviparous. *A*, cornicles; *B*, head and antenna; *C*, cauda; *D*, sculpture of skin.

fine hairs. Length 1·3 to 1·7 mm.

Food plant.—Carum copticum.

Locality.—Bangalore, February, 1928.

Aphis tridacis, sp. nov.

Alate viviparous female.—Head greenish; eyes dark; prothorax dark green, also the mesothorax; abdomen green on the borders, yellowish brown on the dorsum and venter from the first to fifth segment; cornicles green; segments 8 and 9 of the abdomen and the cauda pale yellow; first two antennal segments dark; apical half of femora dark; tibiae pale, except at apices; apex of rostrum dusky. Antennae shorter than body; segment I slightly longer and wider than II; III longer than IV, and IV slightly longer than V or equal to it; VI twice V, base less than the flagellum; III with 6 round sensoria, sometimes one smaller than the others. Head flat in front. Rostrum narrow, reaching just past 2nd coxae. Cornicles rather short and broad, swelling

basally, imbrications marked, long, but wanting near apex; about as long as segment V. Cauda blunt, apex rounded, with 3 pale hairs each side; a little more than ⅓ length of cornicles. Anal plate rounded apically, more or less straight at the sides. A small papilla each side of pronotum, and another on abdominal segment 8. Second fork-cell of wings rather small. When cleared the body shows 3 large dark, lateral spots, a large dark patch

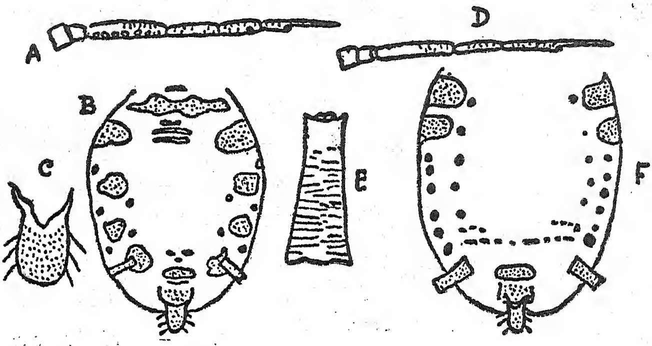


FIG. 6.—*Aphis tridacis*, sp. nov. *A–C*, Alate viviparous; *A*, antena; *B*, body markings, etc.; *C*, cauda; *D–F*, Apterous; *D*, antenna; *E*, cornicle; *F*, body markings.

at base of each cornicle, mainly mesad; 2-3 dark brown lines in front and some small dark spots laterally. Length, 1.4 to 1·5 mm.

Apterous female.—Antennae very thin, about half the length of the body, green; head paler; cornicles dark green; eyes dark; cauda, femora and tibiae pale; tips of tibiae and tarsi dusky. Antennal segment I a little longer than II; III rather more than half as long again as IV; IV and V equal; VI nearly three times as long as V, base less than ½ the flagellum, which is a little shorter than III. Rostrum thin, reaching 2nd coxae. Cornicles a little longer than segment III of antennae, markedly imbricate, but smooth, at the apices. Cauda a little shorter than cornicles, rounded apically; 3 hairs each side. A small papilla each side of pronotum and a pair on abdominal segment 8. Legs rather short. Cleared specimens show two large dark lateral spots on the pro- and mesonotum, small dark lateral abdominal spots and a few mesad of them, and a small oblong dark area before the dark anal plate. Length, 1·3 to 1·5 mm.

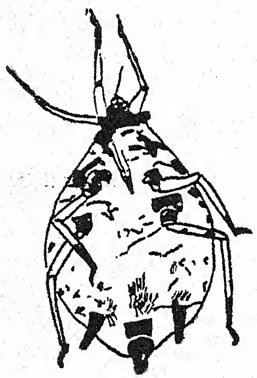


FIG. 7.—*Aphis tridacis*, sp. nov.

Food-plant.—*Tridax procumbens*.

Locality.—Bangalore.

This species is easily demarked by the rather short cornicles being strongly imbricate on most of their length, but quite plain at the apex. The ornamentation in cleared specimens is also very characteristic, especially in the apterae.

Aphis bidentis, sp. nov.

Alate viviparous female.—Body yellowish green; meso- and metanotum dark; cornicles, cauda and head dark; legs pale. Antennae not quite so long as body; segments I and II equal; III much longer than VI; IV longer than V, as long as flagellum of VI; VI with base about ⅔ of V; flagellum faint;

III with 6–8 sensoria in a line; I and II dark; III to V dark, with pale bases. Cornicles cylindrical, expanding basally, imbricate, about as long as segment IV of antennae. Cauda not quite equal to cornicles, rather long, narrower than cornicles, with 3–4 hairs each side. Abdomen with very small lateral papillae and dark lateral spots; a dark patch at base of cornicles, caudad of them. Wings normal. Length, 1·5 to 1·7 mm.

Food-plant.—Bidens pilosa.

Locality.—Bangalore, June 1923.

An obscure species, but I cannot fit it in with any described insect.

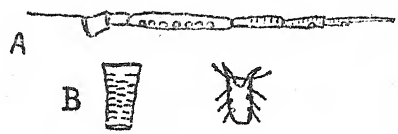


FIG. 8.—*Aphis bidentis*, sp. nov. Alate viviparous. *A*, head and antenna; *B*, cornicle and cauda.

Oregma mysorensis, sp. nov.

Apterous viviparus female.—Yellowish green to completely green with a white mealy fringe; a deep green patch on the dorsum, in some specimens covering the whole abdomen; antennae and legs pale; cornicles deep green.

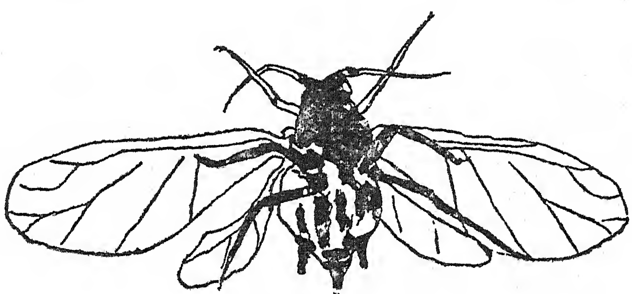


FIG. 9.—*Oregma mysorensis*, sp. nov.

More or less globular, slightly narrowed in front. Antennae of 4 segments, narrow, about ¼ length of the body; segments I and II equal; III very long: IV about as long as I + II. Rostrum rather broad, reaching to 2nd coxae, rather short. Cornicles round, on slightly raised cones, each with 8 hairs. Eyes of 3 facets. Two prominent, blunt horns on the head, as long as antennal segments I and II. Behind the eyes are 3 round wax glands and each side of pronotum, 5–6 each side of mesonotum, 4 each side of metanotum; 8 pairs of lateral wax glands on the abdomen composed of 3–4 glands each, as follows: I, II, III and IV with 4; V with 3–4; VI with 3–4; VII with 4; VIII with 4 one side, 6 the other more central. Anal plate bilobed, with a few hairs. Body with lateral hairs, one arising from each of the lateral wax-pore areas. Cleared specimens show the head, antennae, legs, eyes and apex of the rostrum brown, and the wax-glands, which are more or less round, quite clear. Length.—1–1·4 mm.

Food-plant.—Bamboo.

Locality.—Bangalore.

The young in their first and second instars are greenish all over, the following moults with deeper green patches.

FIG. 10.—*Oregma mysorensis*, sp. nov. Apterous female.

FIG 11.—*O. mysorensis*. Head of apterous female.

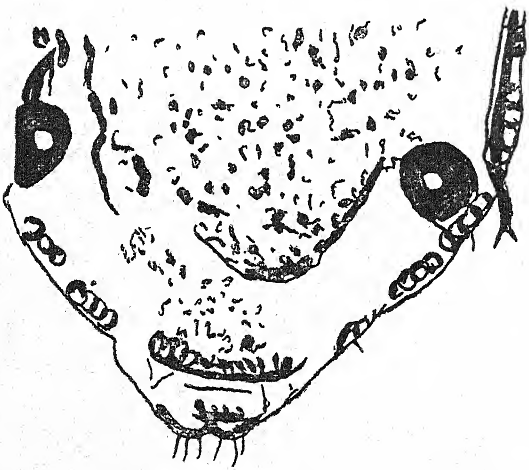


FIG. 12. *Oregma mysorensis*, sp. nov. Apex of apterous female, showing lateral wax-pores.

Closely related to *Oregma insularis* Van der Goot but the antennae have only four segments.

Macrosiphum rosaefolium. Theobald.

This is entirely different from the M. rosaeiformis that Das mentions (*The Aphididae of Lahore*—1918) as occurring on several species of roses in gardens in the Punjab and which he calls the 'Punjab Rose Aphis'. M. rosaefolium occurring in Mysore appears to be the common rose aphis of the tropical regions. The colour pattern of this insect is quite typical and deserves mention.

Alate female.—Body yellowish green; head paler; eyes reddish; III, IV and tips of V and VI and tips of femur and tibia and tarsi, darkish; mesothoracic selerites more yellow than green; tip of rostrum dark.

Apterous female.—Light yellowish green body; eyes red; apices of III, IV and V antennal joints and of cornicles and tips of rostrum and femora and

tibia marked black. Complete VI joint with its spur is dark. Inconspicuous dusky spots present on the sides of the abdominal segments.

The general body colour of the aphids resembles the colour of surface of the rose shoots and buds on which they cluster, so closely that their presence can be detected only on examination at close proximity. The insects are more usually to be found from May–July and October–December.

Host plants.—Different varieties of roses.

Macrosiphum compositae. Theobald.

This does not seem to have been hitherto recorded in India.

The jet black colour of the entire body is quite characteristic and only apterous forms have been found so far.

The following features are of interest.—Prominent diverging tubercles with 2–3 thick slightly capitate hairs on the head ; slender antennae (longer than body) the III article with numerous sensoria ; long cornicles slightly curving outwards at the tips ; long and conical cauda and slightly capitate hairs on the body.

Host plant.—Echinops echinatus.

Taxoptera aurantii. Boyer.

'Most individuals of this species have typical Taxoptera venation and some have typical Aphis venation. The marked striate ornamentation at the base of cornicles is typical.'

Host plants.—Artabotrys odoratissimum, Uvaria narum and *Dalbergia sisoo.*

FIG. 13.—*Taxoptera aurantii* Boyer. Note striate areas at base of cornicles.

Greenidea artcarpi. Westwood.

The comparatively large-sized body with the abdomen and thorax, some times appearing squarish, the long slender and hairy antennae and outwardly curved hairy cornicles and conical cauda, render this insect very easily noticeable on the young shoots, tender leaves and their petioles of the plant ; while the younger stages are pale yellow, sometimes greenish, the adults appear brownish yellow with the centre of the abdomen dark brown. So far this has not been reported as a pest.

Host plant.—Artocarpus integrifolia—Jack.

Tetraneura hirsuta. Baker.

This was collected by Dr. K. Kunhikannan, and is very striking in appearance, looking almost spherical in shape with short brownish legs and antennae, the general body colour being creamy white and sometimes pale yellow.

Sugarcane root aphis found in Pusa have been identified by Theobald as Geoica spatulata in 1926. No root aphis of sugarcane seem to have been recorded from Coimbatore. Das does not mention any sugarcane aphis from the Punjab.

This aphid has not attained the status of a pest in Mysore so far as known.

Host plant.—Roots of sugarcane.

Aphis odinæ. Van der Goot.

This has been so far recorded only from Coimbatore by George. In Mysore it has occurred crowding round tender twigs of mango during the months of February and March; no appreciable damage to mango shoots has yet been noticed. Das does not record this insect as occurring in Punjab.

Host plant.—Mangifera indica.—Mango.

Hyalopterus arundinis. Fabrici.

This insect has only been found in small numbers.

Host plants.—Chenopodium album and *Phaseolus vulgaris.*

Aphis gossypii. Glover.

Since the publication of the 1st list of aphids, during September 1928, this species has been found on Amaranthus spinosus and species of Cassia. Infestation of Amaranthus by this species of aphid has invariably been found to be heavy.

Myzus persicae. Sulz.

This has since been found only sparingly on Phaseolus vulgaris.—(Beans) also.

Brachysiphoniella gramini. Takahashi.

This insect rather resembles species of Brachysiphum of Van der Goot.

Only apterous forms have been found. The body is covered with ash-coloured meal, which dissolves away in alcohol, the insect then appearing green. The cornicles, cauda and 1st two antennal joints are darkish, portions of antennae and legs appear whitish and transparent.

The antennae are about half as long as body; III longer than IV or V but shorter than VI spur.

Cornicles.—Very short, almost truncate; shorter than either VI antennal article or hind tarsus; slightly less than half the length of cauda.

Cauda.—Club-shaped at the tip.

Rostrum just passes the 1st pair of coxae.

Lateral tubercles are absent.

Host plant.—Grass—(The insects were collected from grass blades which were partly submerged under water.)

Cervaphis schoutedeniæ. Van der Goot.

The appearance of this insect is rather deceptive, in that it looks, at first sight, to be some species of scale insect (mealy bug) covered with a thick coating of white meal. Divested of meal, its body colour is found to be greenish yellow. The presence of long branched hairs on the body and the two horn-like structures on the head, together with the long narrow slightly curved cornicles, is very characteristic. Wherever present, this aphid does considerable damage, the leaves and twigs of the plant being heavily infested, which very soon whither, turn yellow and die away. A stronger dose, one lb. in 5 gallons of water of fish oil resin soap than is generally used for spraying against aphids here, has been found to be necessary in the case of this aphid, the usual dose being 1 lb. in 10 gallons of water.

Host plant.—Togare.

Anuraphis helichryisi. Var, warei-Theobald

This aphid produces pseudogalls on the food plant. The leaves curl up, and in the folds, large numbers of all stages of the insect are found present,

rendering the inner surfaces. also sticky with their excretion of honey dew, which, on evaporation, leaves behind very minute, whitish lumps of a substance that looks like shining object on exposure. From September to January, the food plant has been noticed to be very badly infested by this insect. About 20 per cent. of the aphide has, however, also been observed to be parasitised, the parasitised ones appearing as small, sub-circular, yellowish bodies sticking to the inside of the curled up leaves.

Host plant.—Species of *Ageratum.*

FLOWERLESS PLANTS.

BY

MRS. M. ROBINSON, B.A. (T.C.D.), NAT. SCI. TRIP. CAM.

PART IV.

THE BRYOPHYTA.

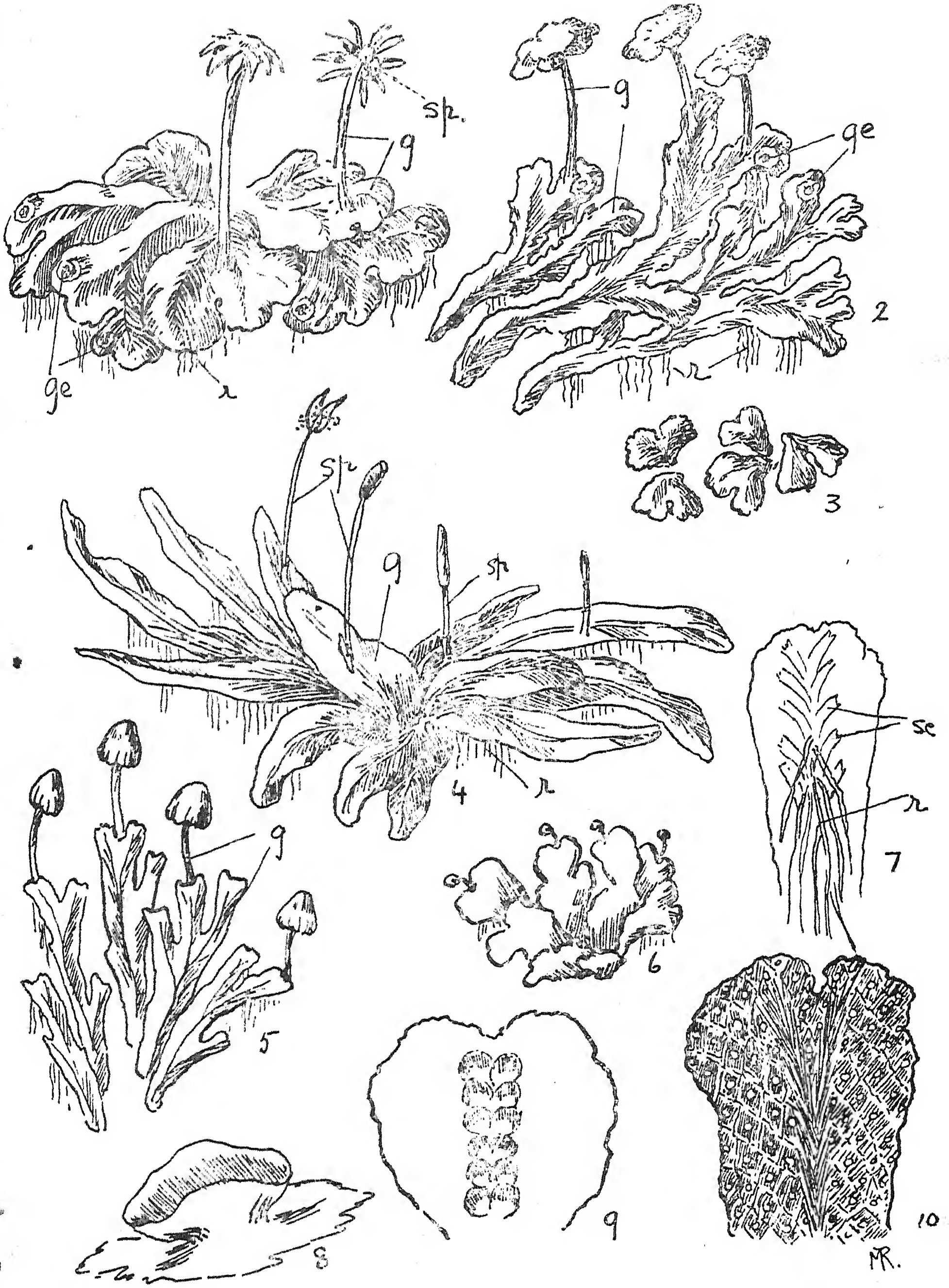
(With five plates and two text-figures.)

(Continued from page 45 of this volume.)

The fourth group of Cryptogamic plants is known as the *Bryophyta*. It contains two large divisions, the Liverworts or *Hepaticæ* and the Mosses or *Musci*.

Mosses are more or less familiar to every one. They form thick green cushions on old walls and tree trunks; or cover bare rocks and stones, and the banks of streams with a soft carpet; while others hang in graceful festoons and tassels from the trees of the tropical jungle. They show an immense variety of form, as may be seen from the few types illustrated on Plate IV, and are always gregarious—a small 'piece of moss' being formed often of hundreds of tiny plants growing closely together.

Liverworts are not perhaps quite so familiar to those who are not botanists, but they are to be found almost everywhere, when sufficient moisture is present. After heavy rains a few kinds like the one shown in fig. 3 on Plate I, appear on bare open ground even in the plains, though they attain their best development and greatest variety in very damp situations, preferably the banks of streams, or on rocks in or near water in a cooler climate. There are two kinds of liverworts; the *thallose* and the *foliose* liverworts which at first sight seem very different. The first group have a thalloid structure, and the body of the plant is a flat, green, dichotomously branched thallus, which may be variously lobed and is distinctly dorsiventral. Rhizoids spring from the ventral side and fix the thallus more or less firmly to the ground and absorb moisture from it, and in many of the species small scales generally of a mauve colour are also found, in two rows, on the underside. A number of different forms of the thallus are shown in Plate I, where it will be seen that the lobes may be broad and rounded, as in fig. 1; or long and narrow with wavy edges as in fig. 2; almost strap-shaped as in fig. 5; and long, narrow and simple with a tendency to a pinnate form of branching as in fig. 4. Sometimes a midrib is clearly marked, in others it is absent, as in fig. 6. There is much variety in size, some of the smaller forms such as *Riccia* in fig. 3 being only a few millimetres long, while the larger forms may attain to a length of several centimetres. The size of these thallose liverworts is found



FLOWERLESS PLANTS.

(*For explanation see end of article.*)

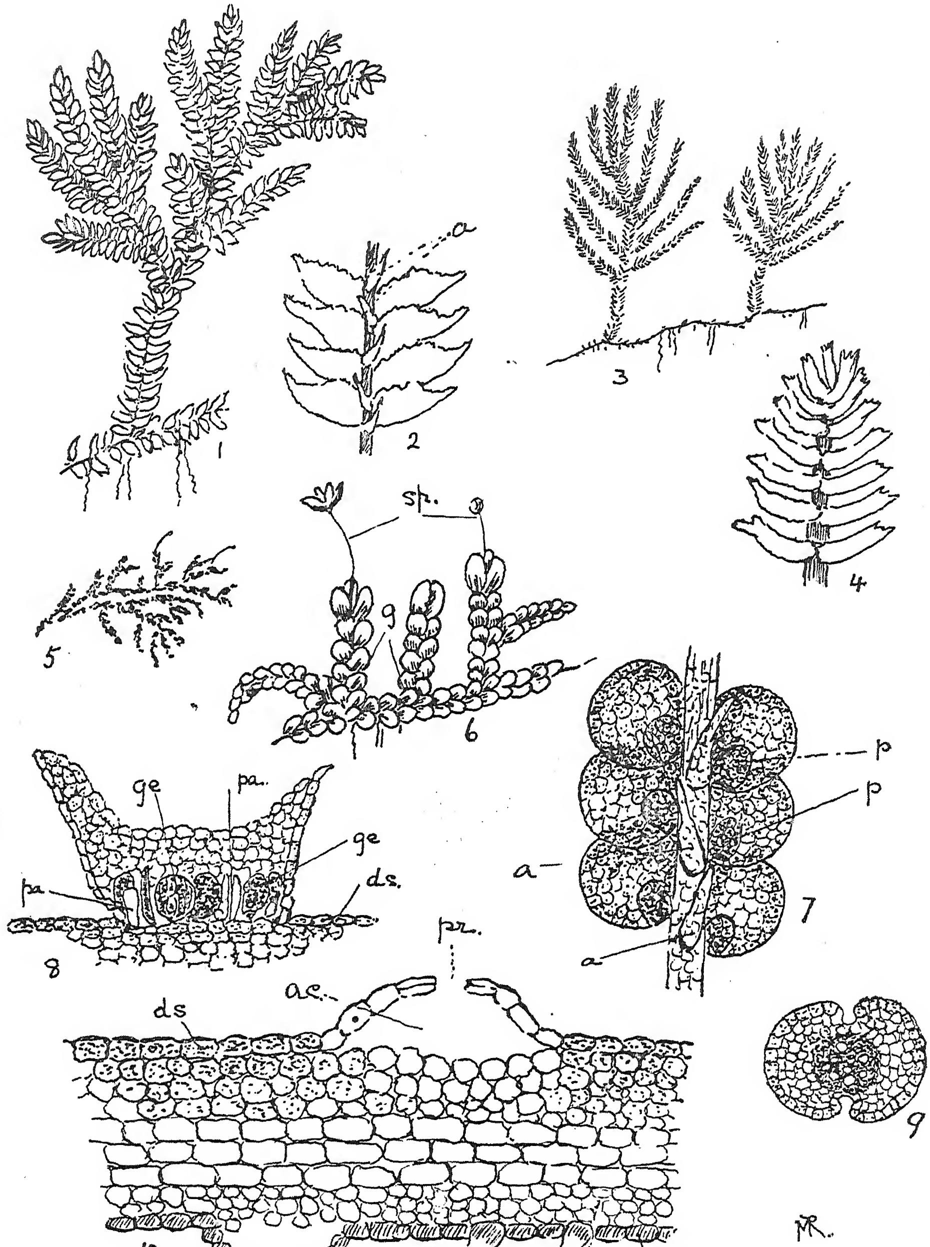
to depend very much on the nature of their habitat, as the same species may show a remarkable variation according to whether it grows in a damp situation, when it will be large, or in a dry place, when it will be found to be very much smaller. The *foliose* liverworts are of a leafy structure having a stem bearing small leaves, and very much resemble the true mosses, being often mistaken for them. Three of them are illustrated in Plate II, figs. 1, 3 and 5, from which it will be seen how much they resemble the mosses, and that it would be difficult to distinguish them without a close examination. The enlarged drawings, figs. 2, 4 and 6, show that the stem bears leaves arranged in pairs with their edges overlapping, on the upper side of the stem, while a third row of very small scale-like leaves is found on the under-side of the stem. These are known as *amphigastria,* and correspond to the scales on the under-side of the thallose forms. The leaves never have any midrib, and this characteristic, combined with the arrangement of the leaves in two rows and the presence of the amphigastria, distinguishes the foliose liverworts from the true mosses.

The mosses have an upright stem with the leaves, all of the same kind, spirally arranged on it, as shown in Plate IV, figs. 2, 3, 4, 5 and 6; or a creeping, or hanging stem repeatedly branched, as in figs. 7, 8, 9 and 10. In some of the creeping forms the leaves appear to be in two rows like the liverworts, but a careful examination will show that the leaves have twisted and assumed this flattened out appearance, due to the recumbent position of the plant, the actual arrangement still being spiral. Considering then only the external characteristics of the *Bryophyta,* the plants of this group seem to show a very definite transition from the lower cryptogams to the higher. Except for their uniformly green character, the thallus of a liverwort shows a remarkable external resemblance to that of many of the foliose lichens. The foliose liverworts, while retaining many of the characteristics of the thalloid forms, yet seem to resemble the mosses even more closely; while among the mosses are many forms which resemble the liverworts on the one hand, and on the other mimic the forms of some of the smaller and more delicate ferns, as for example, the mosses illustrated in figs. 1, 8 and 9.

It must be remembered, however, that these resemblances are merely external and superficial, as the internal structure of even the smallest and simplest thalloid liverwort is entirely different from that of a lichen. The lichen is a compound structure of two different plants, an alga and a fungus, associated in a symbiotic relationship. A liverwort has a definite cellular structure with an outer layer of cells or *epidermis,* with pores or *stomata,* through which air and water vapour can pass to and from the interior of the thallus. Below this a layer of chlorophyll-containing cells and other cells, not containing chlorophyll, make up the interior of the thallus, while rootlets springing from the lower epidermis are of yet a third kind of cell. Fig. 10 on Plate II shows a section through the thallus of a liverwort (*Marchantia*) in which this structure is seen. In fig. 7, which is a piece of the stem and leaves of *Frullania campanulata,* one of the foliose liverworts, the

leaves are seen as flat plates of cells, and the base of each is a little pitcher, in which is sometimes found a particular kind of minute animal organism living in water, known as *rotifer*. This little pitcher is not found in all foliose liverworts, but is peculiar to the genus *Frulliania*. Some of the thalloid liverworts, chiefly the *Marchantias*, bear on their upper surface little green cups or *cupules*, as they are called, which at first sight remind one of the cups on a lichen thallus. These are seen in figs. 1 and 2 on Plate I and contain little green bodies known as *gemmae*, which will develop into a new thallus. They are not spores but correspond rather to the *soredia* of a lichen, and form a vegetative method of reproduction of the thallus. A cupule is shown enlarged in fig. 8 on Plate I and again more highly magnified with its gemmae in fig. 8 on Plate II, while a still more highly magnified gemma is shown in fig. 9, Plate II.

When we come to examine the methods of reproduction by spores in the *Bryophyta*, we find a very interesting state of affairs. On the upper surface of the thallus a number of black dots scattered about can be seen. They are generally near the midrib or centre, or else at the extreme edge. These are shown in *Riccia* in fig. 1, Plate III. On examining these with a fairly high power lens, they are found to be organs, sunk in the tissue of the thallus, and containing spores. The organs are of two kinds, male organs or *antheridia*, and female organs or *archegonia*, and sometimes occur on the same and sometimes on different thalli. In the first case the plant is said to be *monœcius*, in the second *diœcius*. In certain genera of the thalloid liverworts these organs are not sunk in the thallus, but are borne on special branches which arise on the thallus, the two branches being different in appearance for the two kinds of organs. On Plate I, figs. 1 and 2 show the two branches for the same genus *Marchantia;* female in fig. 1, and male in fig. 2. Figs. 5 and 6 show a different type of branch in the genus *Reboulia*, where the male organ is sunk in the thallus, the female being borne on the branch. Figs. 2 and 3 in Plate III show the male and female branches of *Marchantia* enlarged. In the leafy liverworts and in the mosses the antheridia and archegonia are clustered together at the tips of the stem in a little rosette of leaves. They are clearly seen in many mosses like *Funaria*, where the organs are often of a reddish tinge, and look like little flowers, and are in fact often called 'the flowers of moss'. These are shown slightly enlarged in figs. 5 and 6 of Plate V. When examined with a fairly high power lens, the antheridia are seen to be club-shaped bodies containing spores mixed with sterile hairs or *paraphyses*, as in fig. 7 on Plate V. The archegonia are rather flask-shaped, with a long neck and are seen in fig. 8. The similar organs of a liverwort are shown magnified in figs. 5 and 6 on Plate III which are sections through the male and female branches respectively of a *Marchantia*. The spores from the antheridia escape and are carried by water to the archegonia into which they penetrate, passing down the long neck, and fusing with the contents of the lower part of the flask. Thus a true sexual process takes place. The result of this is somewhat surprising. From the fertilized archegonium a structure develops which has no resemblance at all to the original moss or



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liverwort, but is in fact a *capsule* in which is produced a second lot of spores. The development of the capsule of a moss is shown in figs. 9 to 14 on Plate V. The archegonial wall is ruptured and in the early stages the capsule is covered by a little hood or *calyptra* which is the top of the archegonium carried up by the lengthening of the stalk or *seta* of the capsule. Some different kinds of capsules are shown on the mosses on Plate IV, and of the leafy liverworts in figs. 5 and 6 on Plate II. In the thalloid liverworts with special branches, the capsule has no stalk, but is found on the under-side of the special branch, and is shown in figs. 4 a, b and c, on Plate III. Where the archegonium is sunk in the thallus the capsule develops more like that of a moss with a stalk as shown in *Aneura sp.* (fig. 4, Plate I, and figs. 8 and 9, Plate III) and in *Anthoceros* (fig. 7, Plate III.) In liverworts the wall of the archegonium remains as a sheath at the base as in *Aneura* (figs. 8 and 9, Pl. III) and *Anthoceros* (fig. 7) and is never carried up to form a calyptra.

When the spores from the capsule are liberated, they germinate and produce a little moss plant, or a liverwort thallus on which are found once more the antheridia and archegonia. The life history of the *Bryophyta* therefore consists of two well-defined generations; a sexual generation, called also a *gametophyte,* producing an asexual generation or *sporophyte,* which, however, in the *Bryophyta* is always called a *sporogonium.* In all cases the sporogonium remains attached to the gametophyte by its lower part which is known as the *foot,* the whole sporogonium consisting in some cases of the foot, the seta and the capsule, in others of a foot and a capsule only. The sporogonium never has any independent existence, but remains always parasitic on the gametophyte, absorbing nourishment from it by means of the foot. These two generations, gametophyte and sporophyte, follow each other alternately with unfailing regularity, and this rather curious and interesting alternation of generations will be met with again among the ferns.

Having so far treated the *Bryophyta* as a whole and given some idea of the general characteristics of the group, we can now deal with the two divisions in rather more detail.

The Hepaticae.—There are about 4,000 species of the Hepaticae of which the greater number are of the foliose form. The grouping into thallose and foliose forms is a convenient one, as the difference is very striking, but the classification of liverworts, as of all other plants, depends upon their different methods of reproduction, and chiefly on differences in the sporogonia.

There are four families or natural orders.—

(1) *Anthocerotales* (2) *Marchantiales*

(3) *Jungermanniales* (4) *Sphaerocarpales*

Anthocerotales.—This order contains two genera, *Anthoceros* and *Nothothylas.* They are thallose forms and are easily recognized among liverworts, by the long needle-like sporogonia of a delicate green surrounded at the base by a darker green cylindrical sheath. There is no stalk, the whole needle being the capsule which splits downwards from the tip into two valves leaving a central strip of

tissue called a *columella* to which the spores are attached. The two valves twist spirally as they dry. Fig. 7 on Plate III shows a typical *anthoceros* with a rather small irregularly lobed gametophyte which has no midrib and no scales on the under-side. The antheridia and archegonia are sunk in the tissue of the thallus, the remains of the archegonium form the sheath at the base of the sporogonium. *Nothothylas,* which is much less common than *Anthoceros,* is a smaller plant with smaller sporogonia—not so long and slender as in *Anthoceros* and it generally has no columella. The green alga *Nostoe* which is found as a constituent of many lichens is often found in little colonies embedded in the thallus of *Anthoceros* and *Nothothylas.*

Marchantiales.—This order contains two families—*Marchantiaceae* and *Ricciaceae.* They are all thallose forms and vary in size from tiny plants one or two millimetres across among the *Riccias,* to the large lobed spreading plants of *Marchantia* and *Dumortiera* which may be as much as ten centimetres long and twelve millimetres broad.

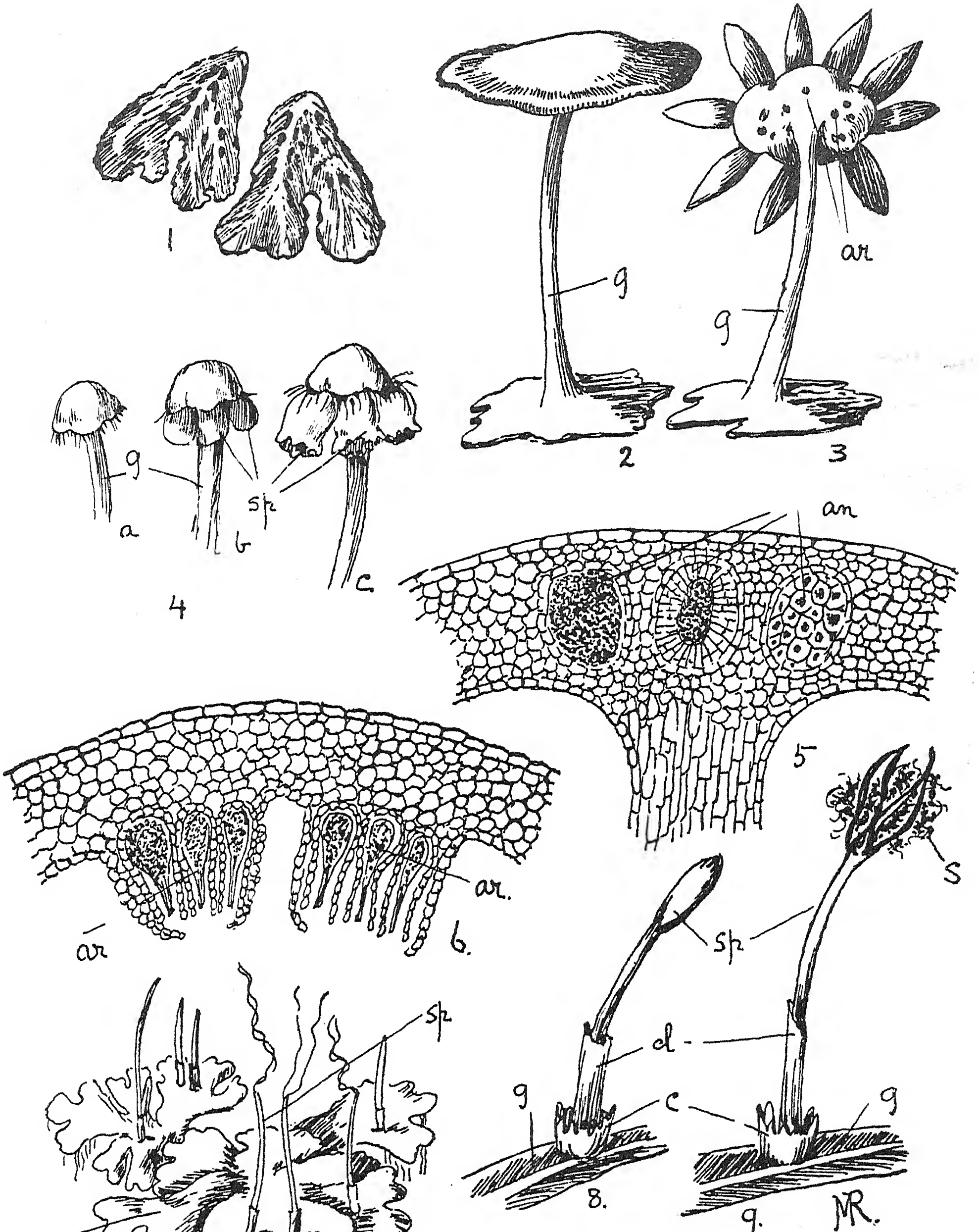
The *Marchantiaceae* include a number of different genera, as many as twenty genera and forty-nine species being described by Professor Shiv Ram Kashyap in his book on the Liverworts of the Western Himalayas and the Punjab Plain—recently published by the University of the Punjab, Lahore.

In this family, the archegonia or female organs are borne on special branches, as described above, so that what resembles the sporogonium of other orders is in reality partly the gametophyte generation, and partly sporogonium. In some genera, e.g., *Marchantia* and *Dumortiera,* the *antheridia* or male organs are also borne on special branches: in others, as *Reboulia, Conocephalum, Fimbriaria,* etc., the male organs are sunk in the tissue of the thallus near the female branches.

Marchantia is one of the best known and commonest of liverworts and its little umbrella-like male branches and its female branches with the nine-rayed star at the top will soon become familiar to the collector of liverworts. The thallus is usually fairly large and much branched, and has a broad and well defined midrib. The dorsal surface is divided up into small rhomboidal areas which can often be seen with the naked eyes; they are known as *areolae* (fig. 10, Plate I), and have a pore in the middle. There are always scales in two and sometimes three rows on the ventral surface, from which spring also the rhizoides.

The family *Ricciaceæ* contains two genera. *Riceiocarpus* which is found floating on water, or in the mud near water and *Riccia* of which some species are floating forms and some are terrestrial. They are all tiny plants, and have their sex organs sunk in the thallus which is usually rather thick. There are no pores on the surface, which is not divided into areolae, though there are air spaces below. There is generally a midrib, usually more prominent on the ventral surface, and scales are generally present, though small and delicate and sometimes absent.

Jungermanniales.—This order contains both thalloid and foliose forms, and some genera such as *Metzgeria* and *Blasia* show a



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transition between the two. Here the thallus becomes thinner towards the edge, which is often only one layer of cells thick and is wavy and indented, showing a rudimentary form of leaves. The thallose forms which are grouped into a suborder *Anacrogynae* usually have a pronounced midrib, and scales on the ventral surface. The sex organs are borne in groups on the dorsal surface, never on special branches, so that the capsule of these liverworts is all sporogonium. The archegonium is usually surrounded by a little involucre or cup remaining at the base of the sporogonium, which has also the remains of the archegonium itself. This is shown in the enlarged drawing of the sporogonium of *Aneura* in figs. 8 and 9 on Plate III. The capsule is sometimes oval as in *Aneura*, sometimes spherical as in *Pellia* and *Blasia*, and splits open by four valves liberating the spores mixed with sterile hairs called *elators* which help in the dispersal of the spores.

The foliose forms of Jungermanniales forming the suborder *Acrogynae* are by far the most numerous of the liverworts, and there are over 3,500 species. *Plagiochila* is a very large genus containing many species, two of which are illustrated in figs. 1-4 on Plate II. The archegonia are always in terminal cluster, and the sporogonium is therefore found springing from the apex of one of the leafy shoots, and has a long stalk with a globular capsule, as shown in the illustration of *Frullania* (figs. 5 and 6, Plate II).

Sphærocarpales.—This is a small order containing the family *Riellaceæ* which used to be classed among the *Jungermanniales* but has been placed now in a different order, from the fact of the antheridia and archegonia being surrounded and enclosed by a special envelope. The gametophyte is thalloid, but some species assume a curious spiral form, as in Riella helicophylla which grows in the Lake of Geneva.

The Musci

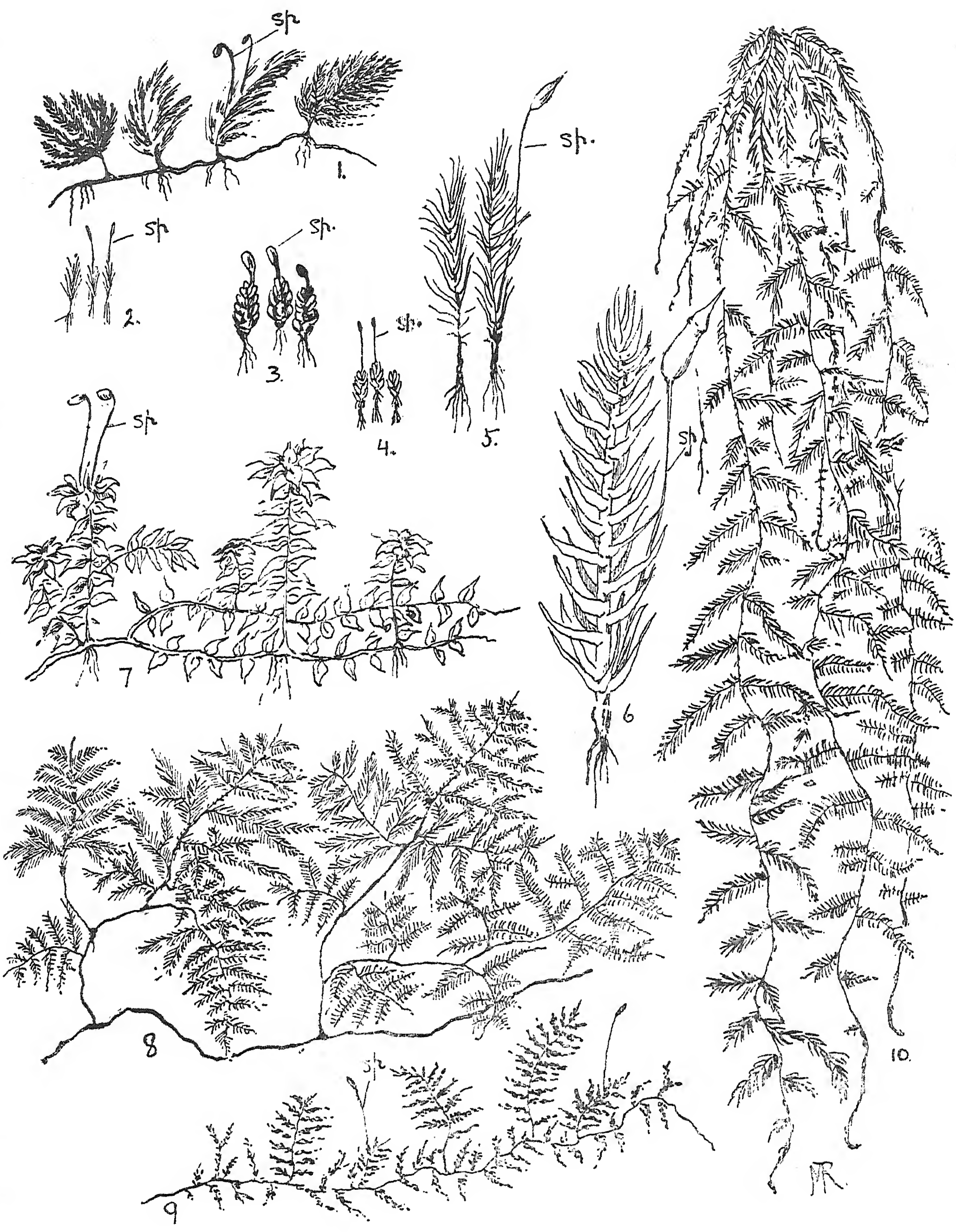
In the mosses, the gametophyte is the little green moss plant with stem, leaves and sexual organs, from which the sporogonium or sporophyte generation is developed. When a spore from the capsule of the sporogonium finds a suitable habitat, it germinates, and produces first a long green branching filament. A number of these together will form a mass of interwoven threads making a thin green film on the rock or earth over which they spread, looking rather like one of the green algae. Very soon, however, there arise on these threads, little buds which develop into the little green moss plants. This thread-like structure which is produced first from the spore is called the *protonema* and is really part of the gametophyte generation, peculiar to the mosses, as it is not found in liverworts. As the little plant develops the protonema gradually dies away and is not found after the early stages of growth. The development of a spore to produce the protonema and moss plant is shown in figs. 1 to 3 on Plate V. The little bud m. soon develops stem and leaves, and later rhizoids to fix it to the soil and absorb nourishment therefrom as the protonema dies away. These rhizoids have

transverse cell walls, differing from those of liverworts which are merely undivided filaments. The leaves, which, as already stated, are arranged spirally on the stem, are also distinguished from those of the liverworts by having a distinct midrib. This means that certain of the cells towards the centre of the leaf are rather more crowded, more elongated in shape and often become empty of their contents. They form a continuous passage with certain cells similarly modified in the centre of the stem, and afford a complete conducting channel for water, absorbed by the rhizoids, to pass up to all parts of the plant. There is thus in the mosses an incipient differentiation of cell tissue, and the rudimentary beginnings of the complex stem and leaf structure found in its highest development in the higher plants, where a woody and water bearing system of cells forms the *vascular* system. It is interesting to note that in one group of the mosses which live almost in water the *sphagnaceæ* or bog mosses, this differentiation of structure in stem and leaves is not found, the whole of the tissue being able to absorb as much water as required.

The sporogonium which develops from the fertilized archegonium varies a good deal in character, size, shape, colour, etc., and on these differences the classification of mosses is chiefly based. The calyptra is sometimes split down one side as in *Funaria* and *Bryum,* in other genera it is complete. The capsule is often oblong or pear shaped, as in *Pogonatum, Hypopteriguim, Mnium, Bryum* and others, or is globular as in *Philonotis* and the *Sphagnales.* When the calyptra has fallen off, the top of the capsule is seen to be closed by a neat little lid called the *operculum* which is rounded or dome-like, or has a little peak or a long tapering point. It is joined to the top of the capsule by a ring of cells called the *annulus.* As the capsule ripens the annulus breaks down and the operculum falls off, disclosing the interior of the capsule which is still protected however by a ring of fine teeth projecting inwards. This is known as the *peristome,* and is very hygroscopic, absorbing moisture and remaining closed over the mouth of the capsule in wet weather, while in fine dry weather the teeth dry up and spread open allowing the spores to escape (figs. 12-15, Plate V). In some genera the teeth are very short, and a thin membrane remains stretched across the top of the capsule, joining the tips of the peristome teeth, and in that case the spores can only tumble out through the little interstices. This membrane is easily seen with the naked eye, as it is usually white, and an enlarged drawing of the top of a capsule of *Pogonatum Neesii* is shown in fig. 16, Plate V. The interior of the capsule has a central mass of tissue or *columella* surrounded by the spores. There are three main divisions of the Musci :—

1. *Sphagnales*
2. *Andreæales*
3. *Bryales.*

Sphagnales contains only one family the Sphagnums or Bog mosses which, as their name suggests, grow in very swampy situations. They cover large areas with a thick carpet and being saturated with water form the treacherous and dangerous bogs which are so common in Ireland and elsewhere. The lower portions



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of the moss gradually die away and sink into the swamp, ultimately forming a large constituent of peat.

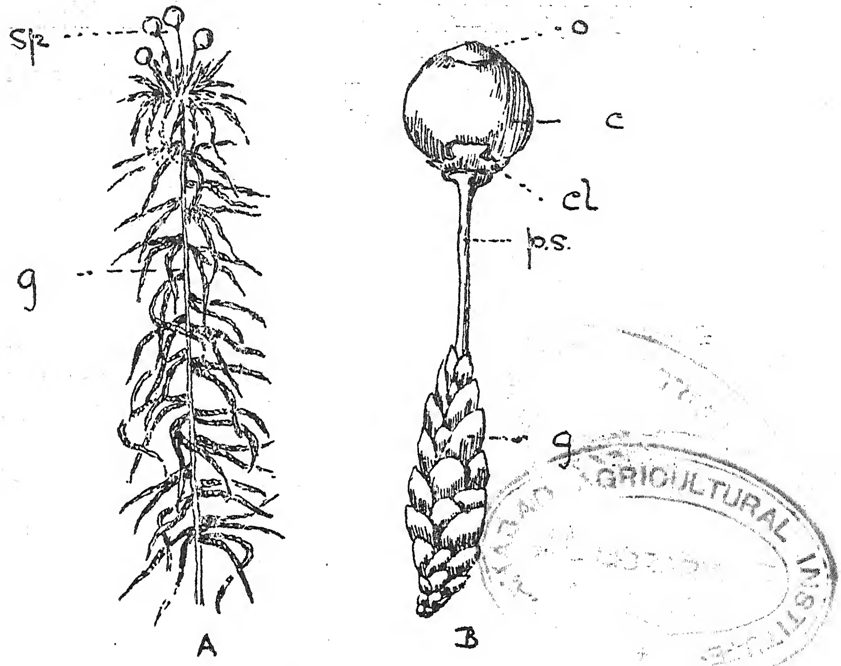


FIG. 1

Fig. 1 :—A. Plant of *Sphagnum fimbriatum* with four sporogonia sp. B. Sporogonium of same enlarged 10 times. *o*, operculum; *c*, capsule; *cl*, remains of archegonium; *ps*, pseudopodium; *g*, gametophyte. (After Strasburger)

Sporogonia are developed often several together at the tips of the branches and the capsule is spherical with a domed operculum. There is no peristome. The capsule is stalked, but the stalk does not develop till after fertilization takes place, and then develops below the archegonium which it pushes up with it, so that at the base of the capsule there is a little cup or sheath, and there is no calyptra at its top. This stalk is called a *pseudopodium*.

Andreæales also contains but one family *Andreæa*. These are very small mosses of simple structure growing in tufts on bare rocks being often among the first plants to appear thereon. Like *sphagnum*, *Andreaea* has a spherical capsule borne up on a pseudopodium but it has also a calyptra at the top. There is no operculum and no peristome and the capsule opens in a manner unlike all other mosses, for it splits into four valves, exactly like *Aneura* and *Frulliania* and other leafy liverworts. These two families thus show distinct affinities with the liverworts in their sporogonium generations, though their gametophytes are typical of the mosses.

Bryales.—This division is a very large one and includes about ninety families, and almost all the true mosses. It is divided into three groups distinguished by microscopic differences in the structure of the peristome teeth, or by the form of the capsule.

(1) *Eubryinales*.—The teeth are formed from dried up cell walls, and the capsule is circular or polygonal in section. The majority of families belong to this group, which is further sub-divided into

(*a*) *Acrocarpeæ* where the archegonia and resulting sporogonia are borne at the tips of the shoots as in *Funaria, Rhodobryum, Mnium, Mierocampylanus* and many others.

(*b*) *Plurocarpeæ* where they are borne on side shoots as shown in *Rhizogonum, Hypopterigium, Ryncostegnum Hypnum,* and most of the creeping stemmed mosses.

(2) *Polytrichinales*.—The peristome teeth are made of entire cells, and often have the membrane stretched between them as in *Pogonatum*, and the capsule circular of polygonal in section.

(3) *Buxbaumiales*.—There are only two families in this group, and the capsule is dorsiventral. *Buxbaumia aphylla* is a very simple type of moss and only produces leafy shoots on the protonema for sexual reproduction.

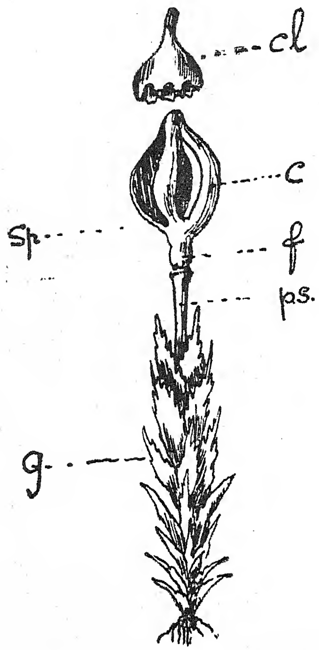


FIG. 2

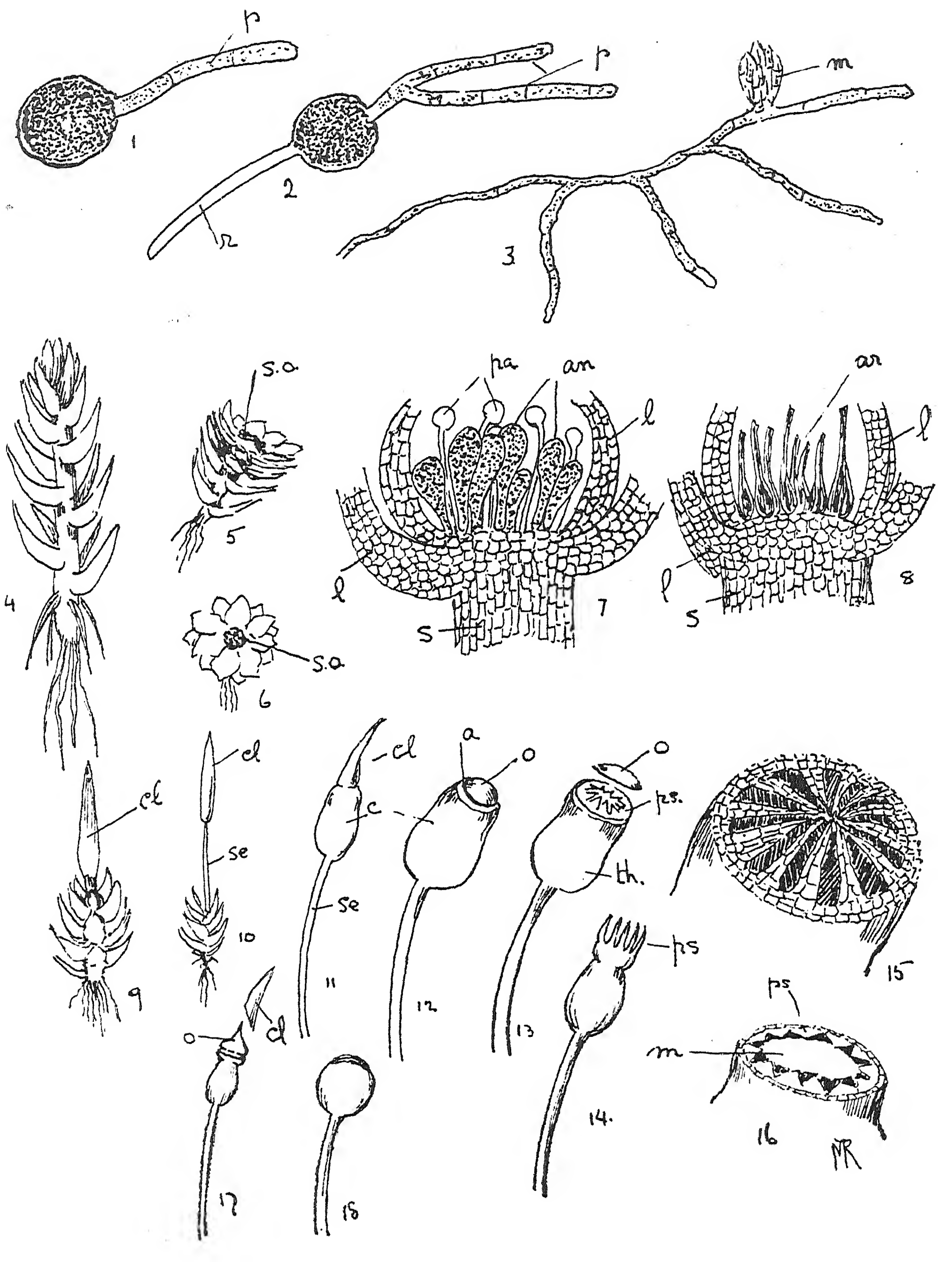
Fig. II :—*Plant of Andreæa petrophylla*. *g*, gametophyte; *sp*, sporogonium; *cl*, calyptra; *c*, capsule; *f*, foot; *ps*, pseudopodium. Enlarged 10 times. (After Strasburger).

The writer would like to acknowledge here with grateful thanks much help from Professor Shiv Ram Kashyap of Lahore in the identification of species of liverworts, and from the Rev. Father Foreau, S.J., of Palamcottah, in the case of the mosses.

PLATE I

SOME TYPES OF THALLOID LIVERWORTS

1. Female plant of *Marchantia* sp. g. gametophyte sp. *sporogonia* ge. gemmae cups.
2. Male plant of *Marchantia polymorpha*.
3. Plants of *Riccia sp*.
4. Plants of *Aneura levieri* sp. *sporogonia* arising directly on the thallus.
5. Plants of a sp. of *Reboulia* showing narrow strapped shaped thallus and special branches bearing sporogonia.
6. Another species of *Reboulia*—thallus has no midrib.



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7. Under side of thallus of *Marchantia* sc. scales, r. rhizoids (Mag. about 8 times).
8. A cupule or gemmae cup. (Mag. 8 times).
9. Under side of thallus of *Reboulia*—showing scales of a different shape (Mag. about 8 times).
10. Upper surface of thallus of *Marchantia* showing division into definite areas or areolae, each with a pore.

Plate II

Some types of foliose liverworts

1. *Plagiochila sp.*
2. Under side of same, showing overlapping leaves in two rows on upper surface, and small scale like leaves a. *amphigastra* on lower surface (Mag. 10 times).
3. Another species of *Plagiochila.*
4. Upper surface (of same mag. 10 times).
5. *Frullania campanulata.*
6. The same mag. 10 times showing sporogonia opening in four valves.
7. Piece of stem of *F. campanulata* mag. about 25 times showing circular overlapping leaves, each with a small pitcher p. at the base, a. amphigastra.
8. Section of cupule showing gemmae ge. and paraphyses pa., ds. dorsal surface of thallus (Mag. 150 times).
9. One gemma more highly magnified. The bright spots in the centre are oil globules (Mag. 250 times).
10. Section through thallus of Marchantia showing a pore pr. with air Chamber ac. below, ds. dorsal surface, vs. ventral surface, s. scales, r. rhizoids.

Plate III

1. Gametophyte of a small liverwort showing sexual organs, a. embedded in the thallus (enlarged).
2. The special branch bearing male organs on the gametophyte of a *Marchantia* (enlarged).
3. Special branch bearing female organs ar. of the gametophyte of a *Marchantia* (enlarged).
4. Stages in the development of the sporogonium on the female branch of a Reboulia. C shows the sporogonia sp. ripe and dehiscing by teeth.
5. Section through male branch of *Marchantia* showing antheridia an. of three different ages (Highly magnified).
6. Section through female branch of a Marchantia showing archegonia ar. (Highly magnified).
7. The gametophyte g. of an *Antheceros* with sporogonia sp.
8. Young sporogonium of aneura—cl. remains of archegonial wall, c. cup like sheath which surrounds archegonia, g. gametophyte (Enlarged about 4 times).
9. Later stage of same—dehiscence by four valves. Mixed spores and elators escaping s. (Mag. about 4 times).

Plate IV

Different types of the gametophyte in the Mosses

1. *Hypopterigium tenelleum.* sp. sporogonia.
2. *Microcampylotus subnanus.*
3. *Schlotheimia grevilleana.*
4. *Funaria hygrometrica.*
5. *Rhizogonum spiniforme.*
6. The same, magnified 8 times, showing spiral arrangement of leaves on stem.
7. *Mnium coriaceum.*
8. *Thuidium cymbifolium.*
9. *Ryncostegnum vagans.*
10. *Barbella determesii.*

Plate V

Development of mosses

1. An asexual spore of a moss with protonema p. developing from it. (Mag. 250 times).
2. Later stage of same with a rhizoid r. also.
3. Threadlike branched protonema with bud m. from which mossplant develops.
4. The gametophyte of *Funaria* hygrometrica mag. 8 times.
5. Gametophyte of *F. hygrometrica* showing rosette at the top enclosing sexual organs.
6. The same seen from the top—s.o. sexual organs.
7. Section through the rosette of a male plant, an. antheredia, pa. paraphyses. l. leaf bases, s. stem. Mag. about 100 times.
8. Section through rosette of a female plant. ar. archegonia. Mag. about 100 times.
9. Sporogonium of *Funaria* developed from an archegonium of which wall has ruptured and been carried up to form calyptra. cl.
10. Later stage. se. seta. Magnified 8 times.
11. Later still. Capsule c. now developed—calyptra cl. still on top.
12. Calyptra now fallen showing *operculum* o. attached by annulus a.
13. Operculum now detached—ps. *peristome* teeth, protecting contents of the teeth.
14. Capsule of *Rhizogonium* showing peristome teeth opened out.
15. Top of capsule, magnified about 50 times, showing cellular structure of peristome teeth.
16. Top of capsule of *Pogonatum* one of the family *Polytrichum* showing very short teeth with membrane m. stretched between them.

THE NOCTUID MOTH

(*EUBLEMMA AMABILIS*, MOORE) ;

A PREDATOR OF THE LAC INSECT, AND ITS CONTROL.

BY

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(*With one colour, 4 black and white plates and 10 diagrams.*)

INTRODUCTORY.

Eublemma amabilis was first described and figured by Moore from Ceylon, but Witt was the first to study the general life history and refer to its injurious nature with regard to the lac insect. Stebbing has some notes on it and has figured its pupa and adult. Hampson records it only from Ceylon, but since his work was published, it has been found widely distributed in India. Lefroy has figured the male insect, but not accurately. Imms and Chatterjee have given a slightly improved account of its life history and distribution, but have given a misleading figure of the male. Misra, who was Entomologist in this Institute from January 1926 to April 1927, has also dealt briefly with the predator. Mahdihassan gives a short account of its presence in South Indian lac and quotes Subramanyam's life history data for one generation. References to it have been made by Lindsay and Harlow, and Withers and Simmons in their respective reports.

The present writers have been working on the predator for the last three years and have had opportunities of examining samples of lac from various parts of India, and it was found that not a single sample received was free from the attack of *Eublemma amabilis*.

THE IMAGO

General description.—

Head with short, white pink hair-scales above; face deflexed, smooth. Thorax silvery white, slightly pink. Antennae in repose stretched in front of the head, basal joint enlarged, clothed with white scales, succeeding joints pinkish yellow. Palpi upturned 3-jointed, clothed with white scales. Proboscis more or less flattened, yellowish in colour. Eyes large, brown, visible from above, facets comparatively large. Legs yellowish-pink ; femora and tibia clothed with long white, and the tarsus with short scales. Fore-wing more or less triangular in form, its description is well given by Moore 'With a broad discal pale pinkish-violet band, the inner border of the band being darkest and indented to the end of the cell, the outer border being also darker and angled outward at the middle median vein, upper radial, and at the costal end ; the entire angulated outer border is also bordered by a prominent white line, which is slightly speckled with black scales; the marginal border of the wing and the cilia suffused with pale pinkish-violet ; hind-wing with a similar pinkish-violet discal band, which is waved and anular only towards the lower end, the outer border line is also pale pink and distinctly speckled with black scales along its entire length ; the outer border of the wing and the cilia also suffused with pale pinkish-violet.' Wing expanse in female (average of 15 specimens) 20·26 mm. in male (average of 15 specimens) 16·46 mm. According to Moore and Hampson respectively the wing expanse is 22·5 mm. and 24 mm.

Anterior half of the abdomen pinkish white, posterior half greyish pink and blackish brown; genitalia protected by tufts of white hair scales. Length of the body in male about 6·86 mm., in female 8·2 mm. When the moth is at rest, the fore-wing completely overlaps the posterior.

External differences between the male and female imago.

	Male (Pl. I, Fig. 1)	Female (Pl. I, Fig. 2)
1. Size and colour.	Generally smaller and duller in colour than the female.	Generally bigger and brighter in colour than the male.
2. Antennae.	47-53 jointed and hairy	41-57 jointed, bear small hairs.
3. Shape of abdomen.	Gradually tapers posteriorly.	Bulges out a little in the middle and then gradually tapers posteriorly.
4. 8th abdominal segment.	Complete; posterior half slightly broader than the anterior.	Incomplete ventrally gradually tapers posteriorly.
5. 8th abdominal segment viewed from the posterior end.	A complete outer circular ring of scales with two inner semi-circular rings of scales on the claspers (Fig. 1*a*).	An outer triangular ring of scales, through which the ovipositor may or may not be seen projecting (Fig. 2*a*).

Colour variation.—

Normally the colour of the moth is creamy white, tinged with bluish, fuscous or pinkish violet with light yellow and brown markings dorsally. The lower surface of the wings in addition may have black spots; but in some cases the moth may be creamy white, tinged with greenish, or greyish suffused with pink and fuscous, or it may have various other combination of these.

Respiratory organs.—

The moth has 8 pairs of open spiracles (Pl. V, Figs. 15, 15*a*) one in the prothorax, in the membrane behind the pronotum, and one in each of the first seven abdominal segments. Each spiracle of the abdominal segments is situated on the upper part of the membraneous pleura. The main tracheal system appears to be the same as that of the larva described in the following pages, but the tracheal trunks and their branches are extremely fine and difficult to follow in detail.

Longevity.—

Under laboratory conditions it has been found that the maximum age of a female moth was 25 days in the month of January; and shortest one day in June and December. For the male moth the maximum age was 24 days in January; the minimum one day in June and October. The average age of a female was 6·5 days (average of 206 females) and of the male 6·9 days (average of 219 males).

Reproduction.—

Sexual reproduction is the only type prevalent in the species. However, unmated females at times lay eggs, but these eggs do not develop and shrivel up after two or three days. Copulation usually takes place at dusk though moths have been noticed copulating in the day in shady and cool places. In captivity copulation freely takes place at all times of the day.

The egg (Pl. II, Figs. 6, 6*a*, 6*b*).—

The freshly laid egg is spherical, depressed in the centre dorsally, pale yellow in colour and furnished with concentric protuberances from either end

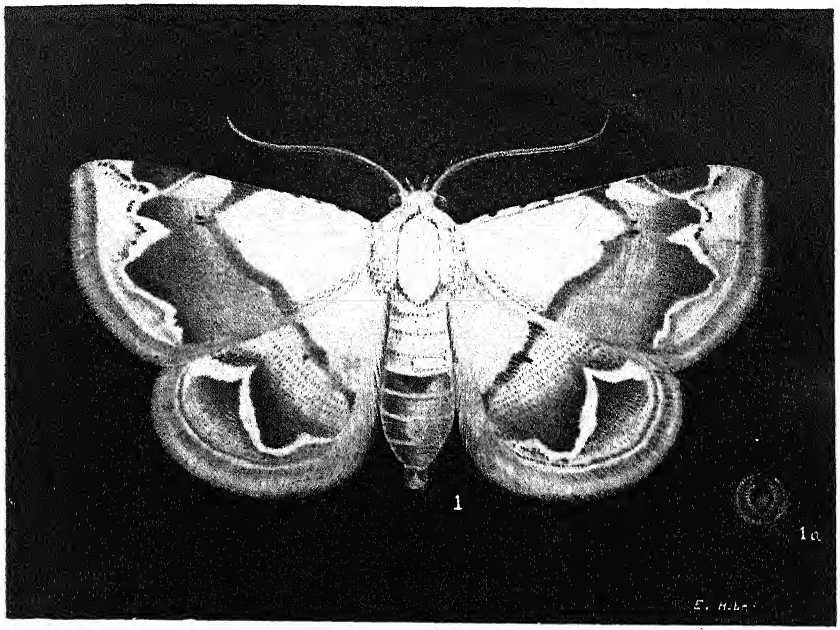


Fig. 1.

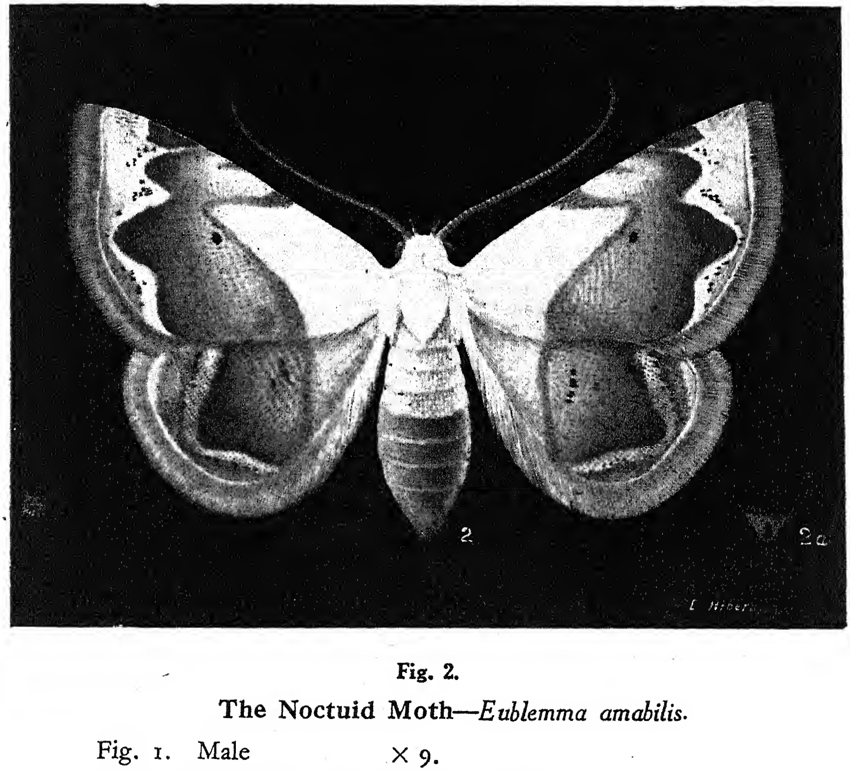


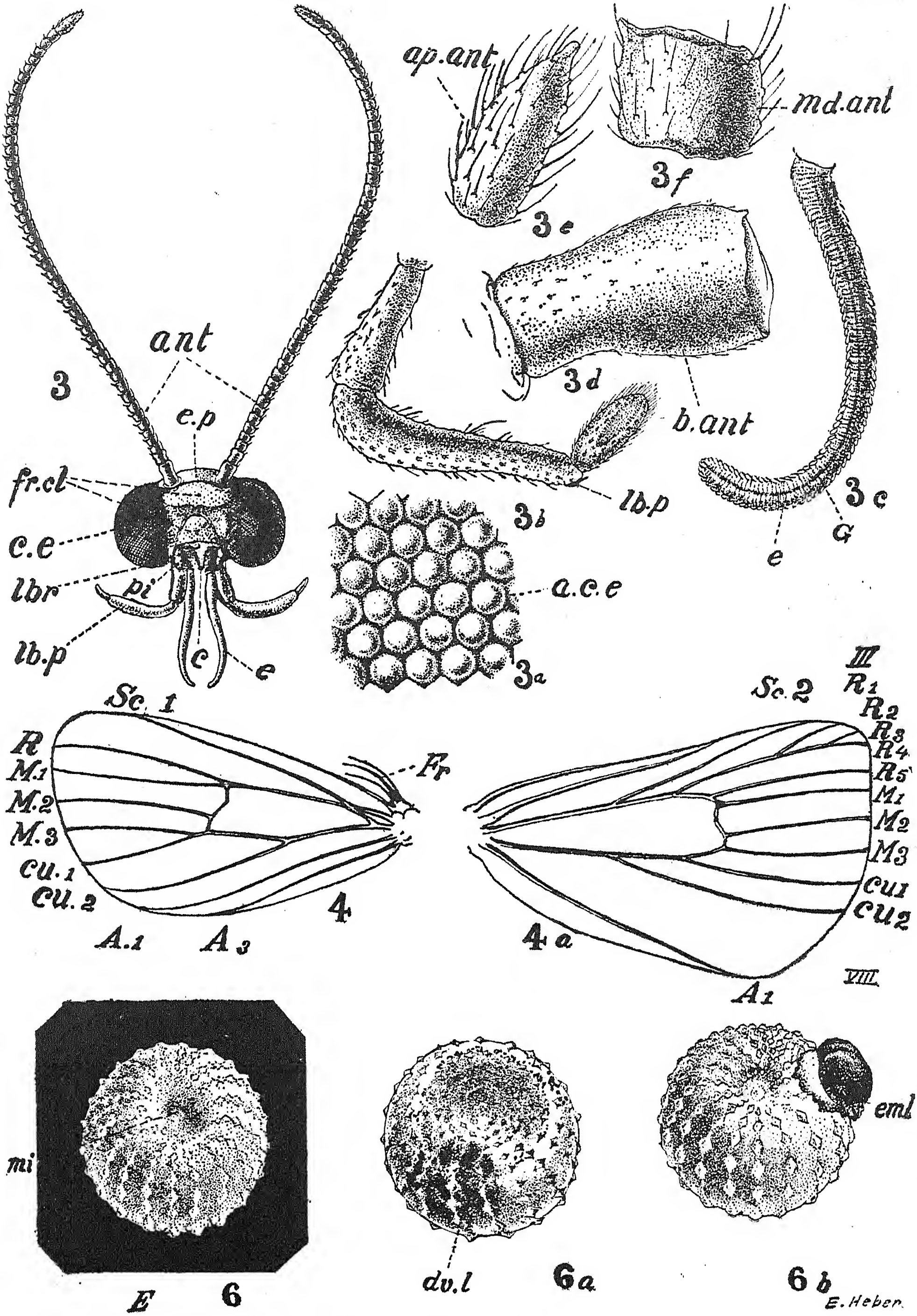
Fig. 2.

The Noctuid Moth—*Eublemma amabilis*.

Fig. 1. Male × 9.

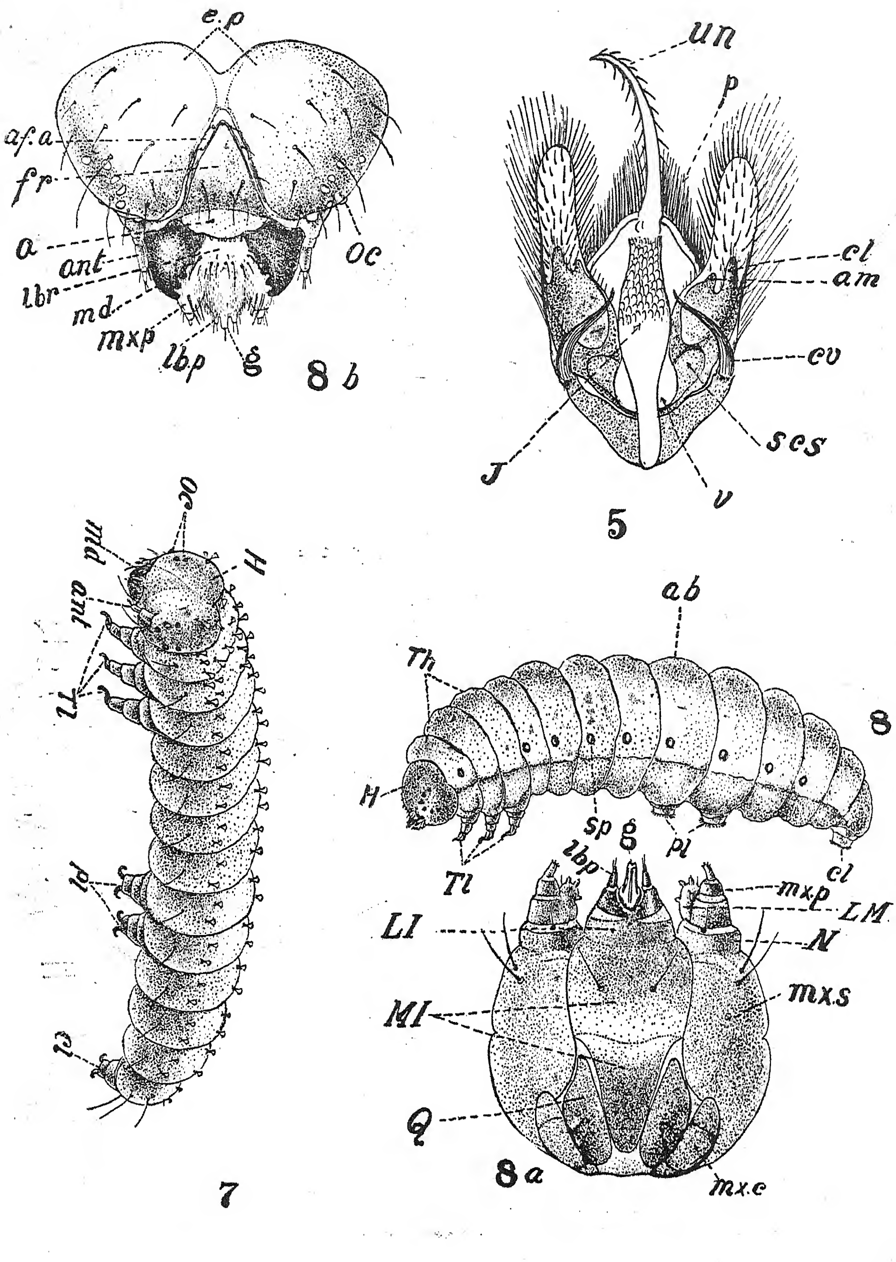
1*a*. Posterior view of the last segment × 18.

Fig. 2. Female × 9.



The Noctuid Moth—*Eublemma amabilis*, Moore.

(*For explanation see end of article.*)



The Noctuid Moth—*Eublemma amabilis*, Moore.

(*For explanation see end of article.*)

to the middle, but smooth and flat ventrally. The depression (the micropylar end) and the concentric protuberances become better marked in a fully developed egg, which measures ·325 to ·375 mm. in diameter and is deep brown in colour.

The larva.—

The newly emerged larva (Pl. III, Fig. 7) is about ·875 mm. in length creamy white and pinkish in colour. With feeding, slight changes occur in its colour till its maturity, but Imms and Chatterjee have gone too far when they say: 'In lac that is approaching the swarming period, the *Eublemma* larvae are deeper crimson in colour, the colour being due to the ingested *Tachardiae*.' And the same may be said about Mahdihassan, who says: 'The absence of red dye in the food of these caterpillars explains the yellow rather than the pink appearance of the adults.' The food contents are in the alimentary canal which cannot be seen through the body wall as the alimentary canal is surrounded by fat bodies. The only organ which can be seen from outside is the dorsal blood vessel which contains a dark red fluid. As such the ingested food can hardly affect the colour of the larva.

The mature larva (Pl. III, Fig. 8) measures about 9 mm. in length, is dirty yellowish white in colour; intersegmental indentations deeper yellow, the posterior eight abdominal segments more yellow than the thoracic and anterior two abdominal segments. It is broadest from 6th–8th abdominal segments and slightly flat dorsally, the 9th and 10th segments gradually tapering posteriorly. Head (Figs. 8*b*, 8*a*) is dark brown in colour and partly retractable into the prothorax; the cardo appears to be 3-jointed—a single maxillary lobe, and 3-jointed palpi; the antennae 3-jointed and small; just behind and a little above the base of each of them are situated six ocelli of unequal dimensions. The prothorax is dorsally brown and chitinous. Thoracic legs are 3-jointed, setose and terminate in large claws directed inwards. The prolegs are borne by abdominal segments 5th and 6th and 10th (anal); each proleg with nine crochets arranged in half rings. The dorsal blood vessel can be seen running from the head to the 8th abdominal segment, the heart being situated in the 4th and 5th abdominal segments.

Points of difference between a newly hatched and mature larva.

(Pl. III).

		Newly hatched larva (Fig. 7).	Mature larva (Fig. 8).
1.	Abdominal segments 8th–10th.	The segments are not very marked; 8th and 9th segments coalesce ventrally.	The segments quite distinct, no coalescence in the 8th and 9th segments ventrally.
2.	Prolegs on 5th, 6th and 10th abdominal segments.	Apparently three lobed, fleshy and end in two curved spines.	Neither lobed nor fleshy, with nine uniordinal hooks (crochets).
3.	Setae.	Cup-shaped.	Bristle-like.

The Setal plan. (Diag. Figs. 1–9).—

The setal arrangement of the first instar and the mature larva of *E. amabilis* differs in many important respects from that described by Fracker in *F. gladiaria* representative of the family Noctuidae studied by him. On the prothorax (Fig. 1) of the first instar larva of *E. amabilis* unlike that of *F. gladiaria*, eta of the kappa group, all the tau group, and sigma are present; gamma is absent and a small seta near the caudal end between beta and delta has made its appearance, which cannot be accounted for and adjusted within the present setal terminology, unless one is ready to accept that gamma has moved to the caudal border and the seta labelled delta is gamma and the small seta between it and beta is delta, but this is hardly plausible because there is no apparent reason for gamma alone to undergo this change; above

sigma at the base of the leg is more than one seta which represent the tau group. The meso-and meta-thorax (Fig. 2) unlike that of *F. gladiaria* show the presence of gamma, theta; and of rho close to epsilon at the cephalic border, and of tau group and sigma. Theta, though a sub-primary seta, seems to have become established on the meso-and meta-thorax of the first instar *Eublemma amabilis* larva. The only other seta for which it could be taken is delta, but comparison with the abdomen shows delta to be missing and this has been accepted by the other workers as a general case in all the *Frenatæ*, this is further confirmed by the fact that in the mature larva the seta occupying this position is theta. On the abdomen (Figs. 5–7) epsilon is distinctly represented as a minute point on the 8th segment but is not clear on other segments, this however goes to confirm the primary nature of the seta, tau is present on the first four and 9th segments and sigma is absent on the 9th. The homology of the setal plan of the 10th segment is not clear.

The mature larva (Figs. 3, 4, 8, 9) shows but slight modification of the chaetotaxy of the first instar larva. This modification is the arrival of mu on the first nine abdominal segments.

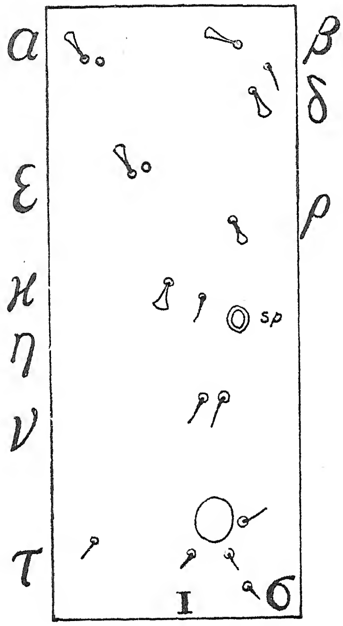
The setal plan of *Eublemma amabilis* larva seems to be of special interest, as it appears to be a connecting link between the *Jugatæ* and the *Frenatæ* and the Microlepidoptera. As in the Jugatæ on the prothorax in the first instar, eta of the kappa group, tau group and sigma are present, and on the meso and meta thorax tau and sigma group are present. Epsilon on the prothorax in the mature larva, as in the Microlepidoptera remains near the cephalic border and does not move as in the Bombycidae close to rho above the spiracle.

Internal anatomy.—

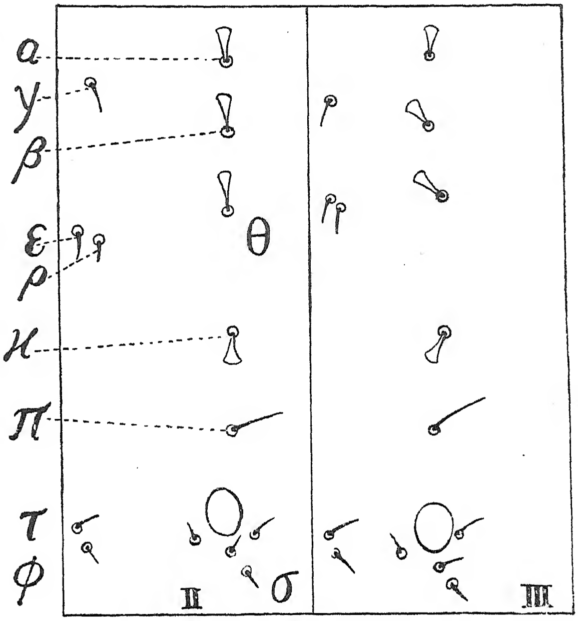
The digestive system (Pl. IV, Fig. 9).—The alimentary canal is a more or less straight tube, the hind intestine is divided into two chambers (colon and rectum). The six Malpighian tubes open on either side by means of a common duct into a small excretory chamber which in its turn opens into the hind intestine. The common duct bifurcates and one branch subdivides, thus giving rise to three tubes on each side. The pair of silk glands (Fig. 11) is most conspicuous, each one of them is an elongated cylindrical tube of nearly three-fourths the length of the entire body. The accessory or Fillipi's glands are reduced to a bifid lobe. The salivary or mandibular glands (Fig. 10) consist of three main lobes and lie in the thorax, one on each side of the fore-intestine and overlapping beneath it; the third is smaller in size and lies medio-dorsally on the fore intestine. Each lateral lobe opens by a duct into the base of the mandible of its side; and the dorsal lobe by a comparatively narrow duct directly into the buccal cavity.

The nervous system (Pl. IV, Fig. 12).—The central nervous system is typical and consists of supra-and infra-oesophageal ganglia, three thoracic and eight abdominal ganglia. The 7th and 8th abdominal ganglia lie on the 7th segment.

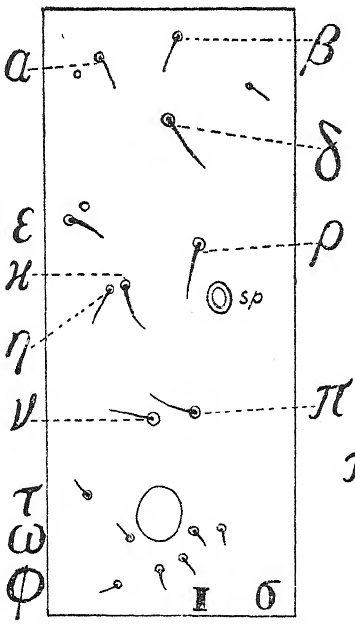
The respiratory system (Pl. V. Fig. 13, 16), is of the peripneustic type. There are 9 spiracles on each side of the body, one in the prothorax and eight in the first eight abdominal segments. Short wide tracheæ run inwards from the spiracles and give rise to three main branches; the smallest arises just near the spiracle, and divides and sub-divides to supply the body wall; the other two arise by the breaking of the main tube into two. One of these joins the lateral trunk, and the other (the dorsal) branch supplies the body wall and viscera, etc. The dorsal branches bifurcate and the sub-divisions further divide and sub-divide and loosely join those of the opposite side, thus forming a system of loops or arches. The principal ventral branches arise, from the lateral trunks in all the segments except the first and last (8th abdominal). Here they may be said to arise directly from the spiracular tube, immediately below the spiracle, and take a transverse course to join their fellows of the opposite side, thus forming a single ventral trunk running between the opposite spiracles. From these, branches are given off to the nerve cord and ventral musculature, etc. The lateral trunks run along the sides of the body. In the meso-and meta-thorax, though the spiracles have totally degenerated and the thin dorsal and ventral branches on either side are directly given off from the longitudinal trunks, yet there is in the meta-thorax, a thin rudimentary spiracular tube clearly seen running from the lateral trunk to the body wall attached in a corresponding position to that of the spiracle in other



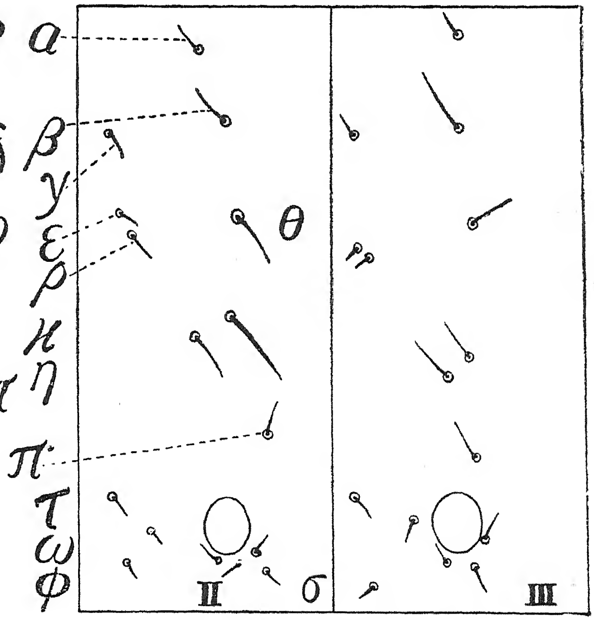
DIAG. FIG. 1



DIAG. FIG. 2

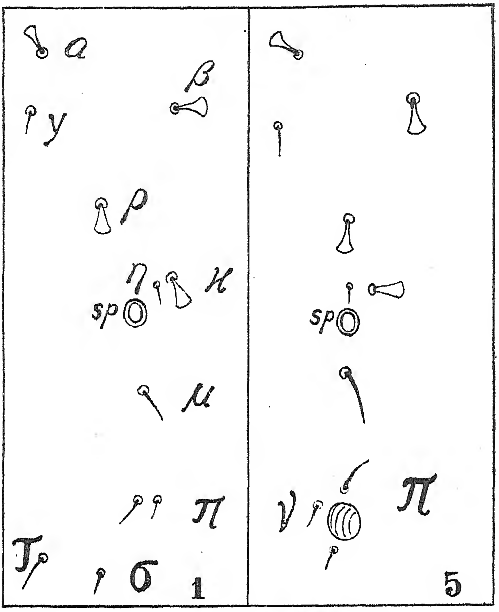


DIAG. FIG. 3

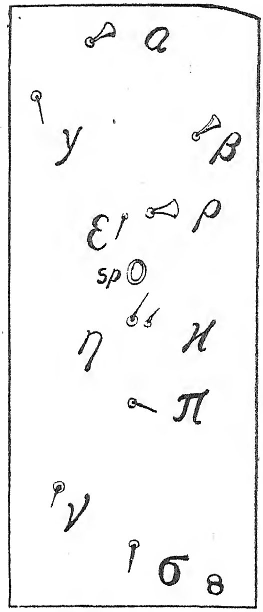


DIAG. FIG. 4

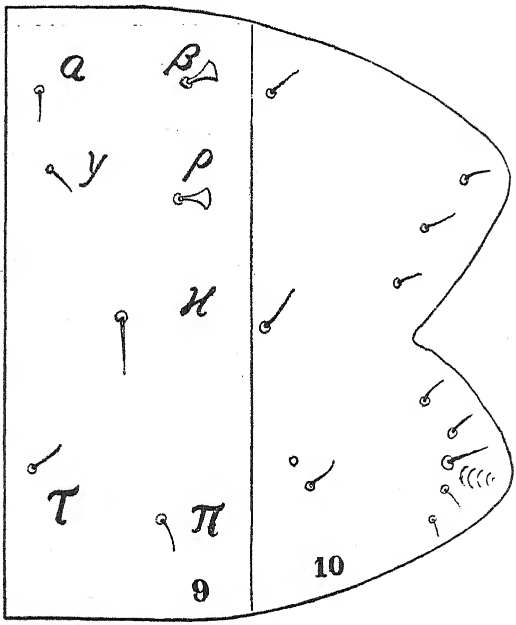
The Noctuid Moth—*Eublemma amabilis*, Moore. Seetal plan of Larva.



DIAG. FIG. 5

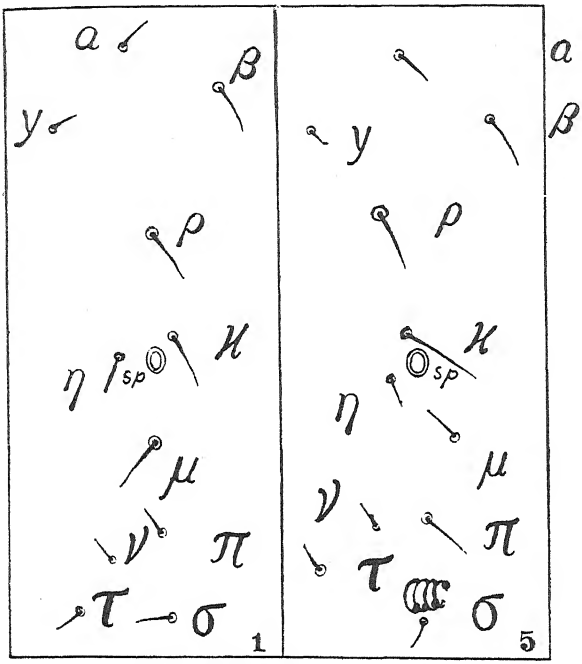


DIAG. FIG. 6

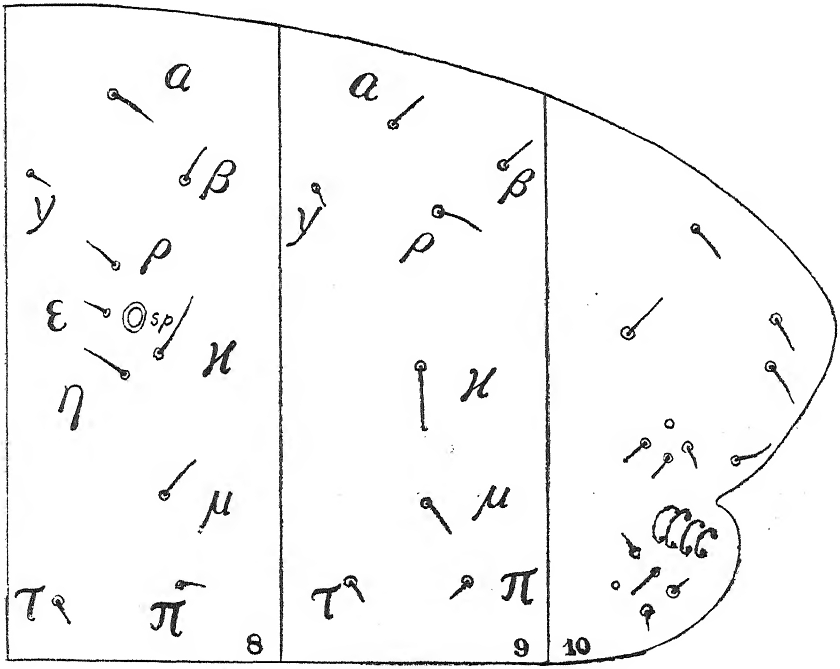


DIAG. FIG. 7

The Noctuid Moth—*Eublemma amabilis*, Moore. Seetal plan of Larva.



DIAG. FIG. 8



DIAG. FIG. 9

The Noctuid Moth—*Eublemma amabilis*, Moore. Seetal plan of Larva.

segments. The ventral trunks of the prothorax, unlike those of other segments, divide into three principal branches and the middle ones of the opposite sides join to form the ventral trunk just behind the epicranium. In addition to the principal ventral branches, practically in all the segments one or two secondary fine transverse branches are given off from the lateral trunks.

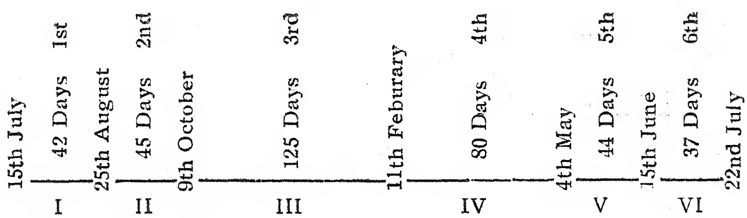
The Pupa. (Pl. V, Figs. 17, 18, and 19).—

It is first pale yellow in colour; all other parts except the abdomen turning to deep brown when the moth is about to emerge. Thirteen segments are visible from above, the largest being the mesothorax, the eyes are small and dark brown, antennae and legs fused ventrally, cremaster present. The free segments in both the sexes are the 4th, 5th and 6th abdominals. The spiracles are present in the prothorax and in abdominal segments 1–7. The genital aperture in the male pupa is situated on the 9th sternum, in the female the 8th and 9th sterna coalesce in the middle line and the common opening for oviduct and bursa copulatrix lies more on the 8th than on the 9th; the anus lies ventrally on the 10th segment.

The pupa lies in its larval passage lined with fine silk threads freely interspersed with the larval excreta, and with a circular hole at one end of the passage. The hole is cut prior to pupation and is lined from below with a silken covering, which is ruptured by the imago while emerging.

Life History.—

Generations.—Though the emergence from our parasite cages, the tables given by Imms and Chatterjee and the results of our breeding cages show the presence of *Eublemma* in large or small numbers in the field practically throughout the year, yet according to the mean life cycle periods in table ii, it seems to have six generations (diag. fig. 10) in twelve months and eight days in all places throughout India where only two crops, i. e., June-July (Jethwi) and October-November (Katki) including the Aghani (January-February) and Baisakhi (April-May) are reaped. This has also been pointed out by Mahdihassan in his *L. mysorensis* which is reported to take 13 lunar months to complete three life-cycles, though he does not support his conclusions with data. Imms and Chatterjee were therefore wrong in concluding: 'There are two generations in the year, and possibly in the hottest localities there are three such broods'. July has been chosen as the beginning of the year as it is more convenient from the point of view of lac cultivation, and by the 15th of this month practically throughout the country, brood lac for both the Katki (October-November) and Aghani (January-February) is infected on the host plants.



Diag. Fig. 10.

The life cycle of the predator is not as simple as represented above. The complexity begins with the third generation. The eggs laid in October, as will be seen from Table Nos. 2, 3, 4, develop and a part of the adult emergence takes place in November and a part hibernates in the Aghani crop which matures in January-February and in the Katki stored lac, i.e., Ber (*Z. jujuba*) and Palas (*B. frondosa*), etc., which has been reaped and kept in store after and before the inoculations. A portion of the brood which hibernates nearing or in the pupal stage emerges in December-January and the remainder emerges in February-March. Thus the October generation (generation three)

emerges continuously from November to March. Most of the eggs laid by this generation on Baisakhi and Aghani do not develop due to cold, but those which survive, and develop further, emerge as adults in March–April and May. This is the fourth generation. The eggs laid by this develop and emerge as adults in different months till the first half of June. This is the fifth generation. The eggs laid by these in May and first half of June generally do not develop due to heat. A few that do develop emerge in June or along with those laid in the second half of June, in July and August. This is the 6th generation. The 4th and 6th generations develop under very trying conditions.

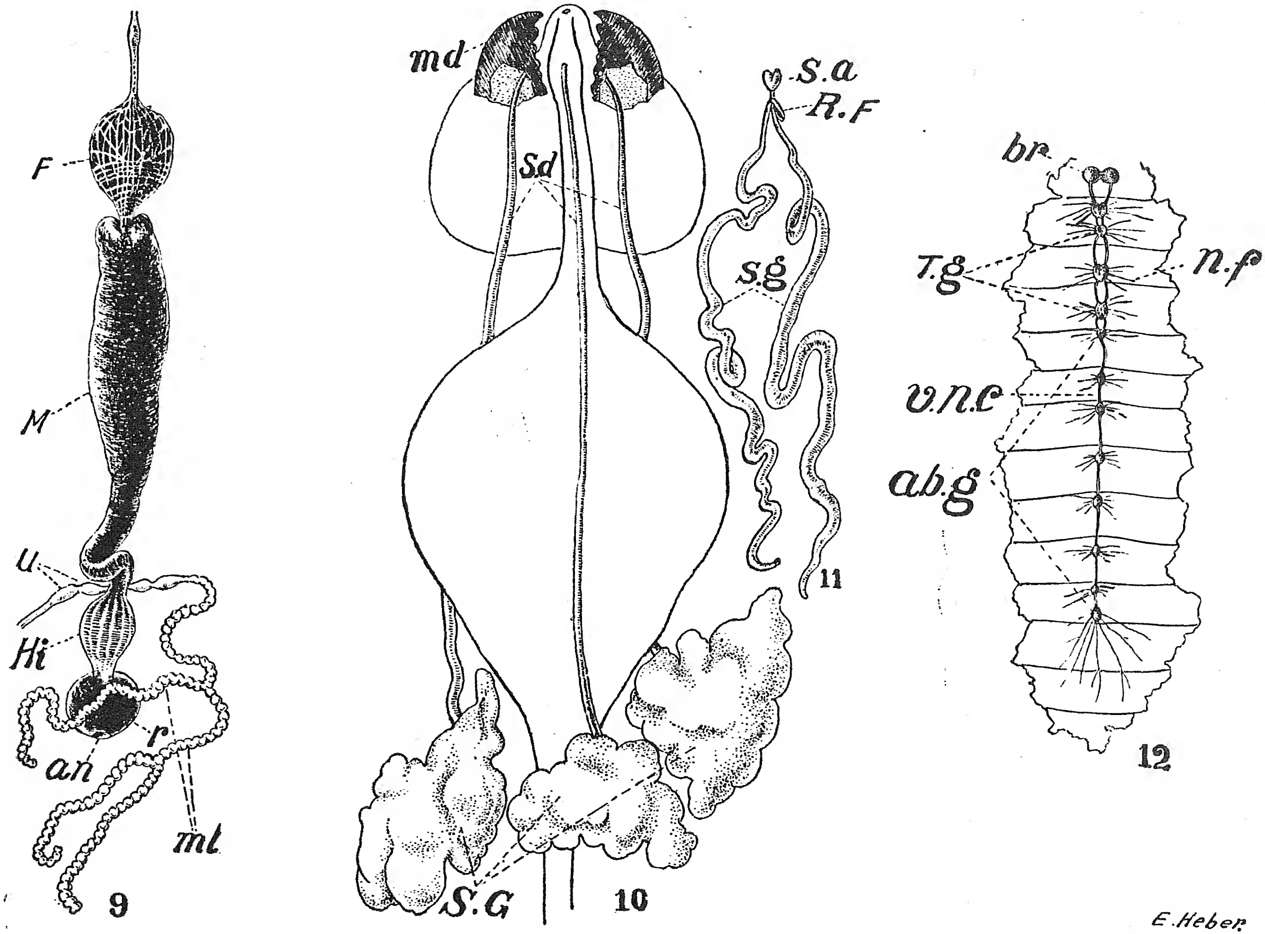
Mating.—As soon as the moths emerge, they seek shelter on the lower part of the leaves of the host plant or in a less lighted place in the vicinity till dusk, when they presumably fly about in search of mates. After a mate has been secured, the pair remain in copula until after dark, and do not separate easily even if disturbed. The eggs are laid soon after copulation. In the laboratory in six cases, the female began to deposit eggs from 2½–7 hours after copulation. Besides this, in the laboratory under confinement, eggs were laid by females hitherto virgins, 1–13 days after the introduction of males. Misra who has quoted this datum of ours has incorrectly put 1–13 days after fertilization. This shows that the mating does not begin as soon as a couple comes together. The female continues to deposit eggs from 1–10 days after she has begun egg laying.

Egg-laying and hatching.—In the field the eggs are laid singly as well as in batches of 2–40, the common number in a batch being 2–6. They are laid between the developing larvæ of the lac insect, in the crevices of the lac incrustation and sometimes on the incrustation also; this depends on the stages of development of the lac insect; in the early stages, *Eublemma* invariably lays eggs between the lac cells or at the side of a single cell, but when the incrustation becomes continuous, it lays eggs in the crevices generally and sometimes on the encrustation itself. In the laboratory the eggs are laid on the sides of the jar, on the papers covering the jar, round the holes for ventilation and sometimes in the holes too. The egg-laying period varied from 1–10 days. The female continues laying eggs even after the death of the male, but the rate becomes less. *Eublemma amabilis* moths are more fertile during the Katki crop than in the Baisakhi, they lay a much larger number of eggs in the months July–October than in the other months of the year. This has been observed both in the laboratory and in the field. The minimum and the maximum length of the egg stage and the period within which all the eggs laid on the same day hatch (i.e., duration of hatching) for eleven months are given in Table No. 1.

TABLE NO. 1.

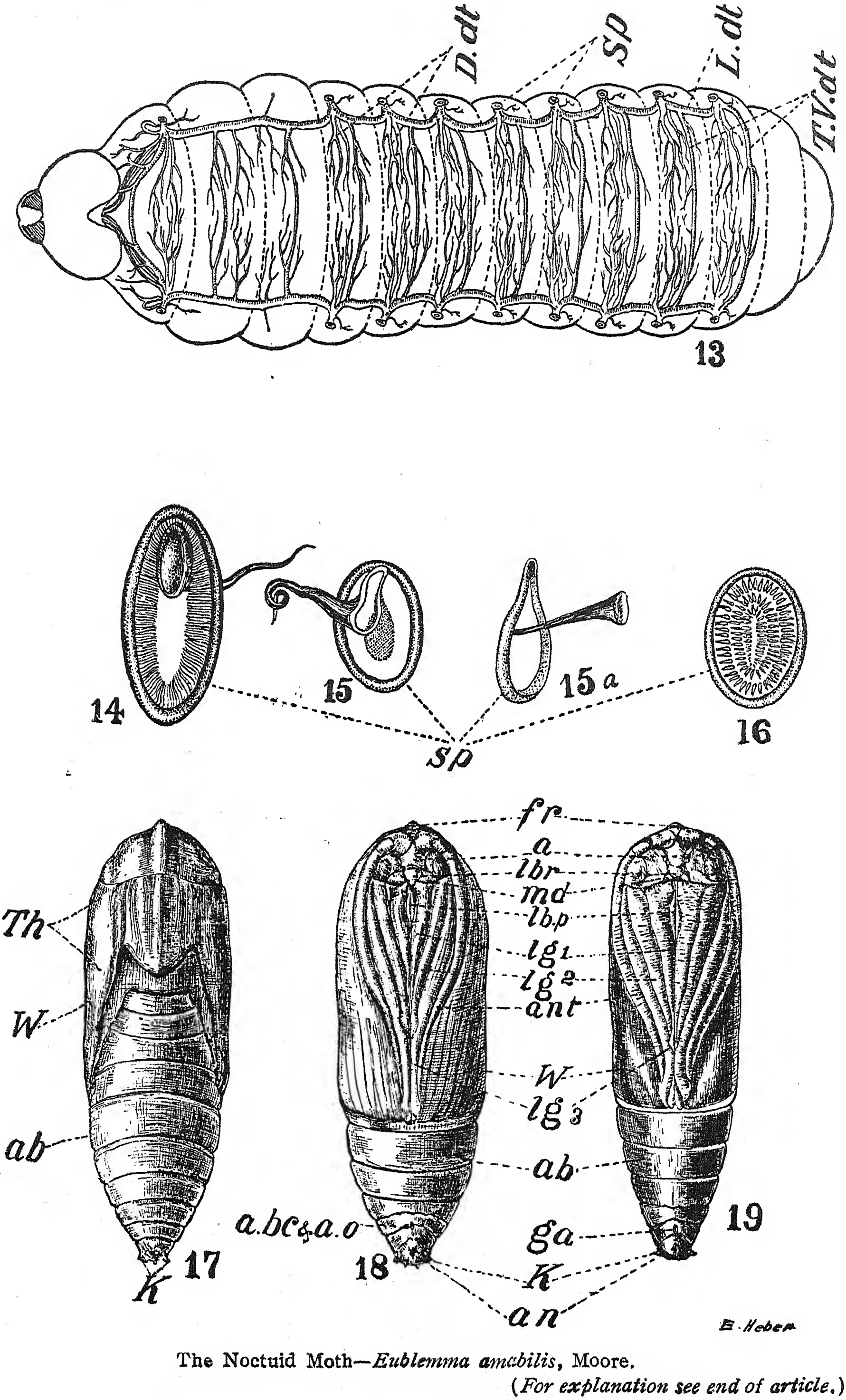
Month	July	August	September	October	November	December	January	February	March	April	May	June
Length of egg stage in days.	5–7	4–20	4–20	3–11	6–37	14–52	20–27	9–23	6–16	5–10	–	4-7
Duration of hatching in days.	1-2	6 hrs.-15	1-15	6hrs.-5	1-18	1–31	1–8	1–4	1–5	1-2	-	1-3

The table shows that the length of the egg stage and the duration of hatching rises continuously from November–February (in generation 3) and begins to drop from March–June in (generations 4 and 5) and remains more or less at its lowest from June to October (generations 6, 1 and 2). The mortality of eggs laid from November–February and May to first half of June is much



The Noctuid Moth—*Eublemma amabilis*, Moore.

(*For explanation see end of article.*)



The Noctuid Moth—*Eublemma amabilis*, Moore.

(*For explanation see end of article.*)

greater than in any other generation. This can only be accounted for by cold and heat.

The embryo, when fully developed within the egg shell, bites a hole laterally, and generally thrusts its head out first, presses its thoracic legs against the inner-side of the shell and fixes its anal end close to the thorax. It then relaxes its thoracic hold, pushes the anterior end forward through the hole, and subsequently relaxes its anal hold and draws its posterior end either by alternate expansion and contraction of the part of the body which is outside the shell or by fixing its thoracic legs on the adjoining egg and slowly drawing out the posterior part, taking from 45–69 minutes. But in certain cases the larva, after biting the hole, moves round and throws out its anal end first, fixes the anal legs on the adjoining shell and by relaxing the hold of the thoracic legs wriggles out slowly in 1·5 hours–36 hours.

The larval stage.—The newly-emerged tiny larva bites a small hole into the incrustation and begins to feed on the developing male and female lac larvæ within the resinous tests. The larva, as it grows, continues tunnelling below the encrustation and feeding on a large number of lac insects. The full-fed larva is creamy white with a pinkish tinge. It lines its passage with fine whitish silk threads and leaves the pink circular discs of excreta surcharged with resin in the passage as it proceeds onwards. Prior to pupation, it makes a large circular hole into the incrustation and lines it from below with the fine silk lining. A single caterpillar devours from 40–45 mature cells in its full larval life.

The larva appears to moult ten times prior to pupation. This is fully supported by the calculations based on Dyar's law (larval head measurements).

1st instar width of head	...	·18 mm.
2nd ,, ,, ,,	...	·225 mm.
Average ratio	...	1·25 mm.

Calculated widths of head in mm.			Observed widths of head in mm.
1st instar	...	...	·18
2nd ,,	·18 × 1·25 = ·225	...	·225
3rd ,,	·225 × 1·25 = ·281	...	·275
4th ,,	·281 × 1·25 = ·351	...	·375
5th ,,	·351 × 1·25 = ·438	...	·425
6th ,,	·438 × 1·25 = ·547	...	·550
7th ,,	·547 × 1·25 = ·685	...	·650
8th ,,	·685 × 1·25 = ·853	...	·825
9th ,,	·853 × 1·25 = 1·066	...	1·125
10th ,,	1·066 × 1·25 = 1·332	...	1·357

The length of the larval stage (Table 2.) also varies according to the seasons of the year and more or less follows the same rule as the egg stage.

The pupal stage.—The full-fed larva ultimately pupates in the larval passage under a tough cover of its excreta. The length of the pupal stage (Table 2.), also varies according to the seasons of the year. It is lowest in generation 4 and gradually rises in generations 6, 1 and 2 and is highest in 3. The moth emerges through a rupture in the pupal coat and then ruptures the silken covering over the mouth of the circular hole, sits for a while near the hole and then flies away. The following table represents the life cycle of *Eublemma amabilis* collected and summarized from the breeding cages. Misra has incorrectly quoted a few of our life history figures on p. 92 of *Pusa Bulletin*, No. 185.

The correct figures would be as follows:—

Eggs laid	...	7–x	2–x	2–x	6–x
Eggs hatched	...	13–x	8–x	7–x	11–x
Larva pupated	...	11–ii	5–ii	4–ii	4–ii
Adult emerged	...	18–ii to 25–ii	24–ii	28–ii	28–ii
		134–141	145	149	145 days.

TABLE 2

Month	Eggs laid on.	Eggs hatched on.	Egg stage in days.	Pupated on.	Larval period in days.	Adult emerged on.	Pupal period in days	Total life history period in days and the sex of the moth.	Average life history period of eggs laid in each month in days.
January ...	2·1	22·1	...	...	...	...	...	...	
	8·1	29·1	21	23·4	84	2·5	9	114 ♀	114
	9·1	29·1	...	...	...	...	...	...	
February ...	8·2	22·2	14	27·4	64	6·5	9	87 ♀	
	9·2	23·2	14	18·4	54	28·4	10	78 ♂	80
	9·2	24·2	15	22·4	57	30·4	8	80 ♀	
	12·2	25·2	13	22·4	56	1·5	9	78 ♀	
March ...	5·3	15·3	10	24·4	40	4·5	10	60 ♂	72
	16·3	23·3	7	28·6	97	8·7	10	114 ♂	
	23·3	29·3	6	2·5	34	5·5	3	43	
April ...	4·4	9·4	5	11·5	32	21·5	10	47 ♂	
	4·4	9·4	5	4·6	56	12·6	8	69 ♂	51
	4·4	9·4	5	12·5	33	22·5	10	48 ♀	
	24·4	30·4	6	25·5	25	3·6	9	40	
May ...	...	...	...	...	...	...	...	...	44 Mean of April and June.
June ...	14·6	19·6	5	5·7	16	15·7	10	31 ♂	
	14·6	19·6	5	6·7	17	17·7	11	33 ♀	37
	20·6	25·6	5	22·7	27	4·8	13	45 ♀	
	24·6	29·6	5	22·7	23	3·8	12	40 ♂	
July ...	2·7	7·7	5	26·7	19	3·8	8	32 ♀	
	2·7	7·7	5	26·7	19	10·8	15	39 ♂	42
	26·7	2·8	7	3·9	32	13·9	10	49 ♀	
	27·7	3·8	7	2·9	30	12·9	10	47 ♂	
August ...	5·8	12·8	7	2·9	21	12·9	10	38 ♂	
	6·8	13·8	7	2·9	20	13·9	11	38 ♀	45
	19·8	26·8	7	4·10	39	16·10	12	58 ♂	
	30·8	6·9	7	28·9	22	13·10	15	44 ♀	
September ...	22·9	28·9	6	22·10	24	5·11	14	44 ♂	
	22·9	28·9	6	24·10	26	6·11	13	45 ♀	45
October ...	1·10	7·10	6	6·11	30	26·11	20	56 ♀	
	2·10	8·10	6	5·2	120	24·2	19	145 ♂	125
	2·10	9·10	7	14·2	128	16·3	30	165 ♀	
	7·10	13·10	6	11·2	121	18·2	7	134 ♂	
November ...	2·11	8·11	6	24·2	108	13·3	17	131 ♂	
	5·11	14·11	9	...	...	...	...	...	131
	16·11	1·12	15	...	...	...	...	...	
	26·11	13·12	17	...	...	...	...	...	
December ...	3·12	17·12	14	6·3	79	22·3	16	109 ♂	
	5·12	19·12	14	26·3	97	4·4	9	120 ♂	114
	16·12	15·1	30	...	...	...	...	...	
	23·12	26·1	34	...	...	...	...	...	

F. N.—In striking the average only complete life cycles, have been taken into account.

Life history figures of Subramanyam quoted by Mahdihassan for generation 3, i.e., eggs laid in November, do not apply to Northern India.

Crop Statistics.

Stick Examination.

Tables 3 and 4 show the mean presence of *Eublemma amabilis* reduced to per hundred inches from the years 1926–29.

TABLE 3.

(Aghani in ordinary type ; Katki in **bold**).

—	July	August	September	October	November	December	January	February
Eggs unhatched.	60·6 **41·7**	204·5 **88·6**	6·3 **19·7**	150·9 **13·2**	67·6	25·0	...	...
Eggs hatched ...	3·0 ...	139·4 **116·7**	22·7 **19·1**	187·8 **38·4**	17·8	69·5	69·0	50·0
Larvae ...	... ...	147·4 **88·5**	66·9 **77·6**	203·9 **66·4**	44·5	55·5	96·0	50·0
Pupae full ...	... ...	6·2 **1·3**	6·1 **6·1**	3·7 **2·5**	8·1	5·7	9·9	7·0
Pupae empty ...	... ...	1·5 **0·5**	4·7 **5·6**	5·0 3·7	41·0	14·0	52·0	54·0

TABLE 4.

(Jethwi in ordinary type ; Baisakhi in **bold**).

—	November	December	January	February	March	April	May	June	July
Eggs unhatched.	**9·0**	**9·0**	**25·5**	... **6·8**	14·0 **12·5**	45·4 **25·1**	27·0 **5·8**	8·4 **19·2**	194·4 **154·5**
Eggs hatched ...	**1·6**	**16·5**	**2·5**	... **13·3**	7·4 **18·8**	37·1 **54·1**	18·0 **37·6**	4·1 **25·4**	49·8 **109·1**
Larvae ...	**3·2**	**19·5**	**5·1**	... **8·4**	7·2 **19·3**	37·4 **39·4**	13·0 **34·2**	12·5 **15·6**	48·6 **162·8**
Pupae full ...	...	...	...	... ...	... **2·2**	... ...	13·0 **3·5**	4·0 **4·5**	.. **26·0**
Pupae empty ...	...	...	...	... ...	... **2·0**	... ...	2·0 **3·0**	... **4·4**	16·6 **26·2**

The examination of each crop was made a week after inoculation to the time of infecting the next crop. A careful study of the tables shows the relative

dominance of the predator in the Aghani and Katki over that in the Baisakhi and Jethwi and, that in each season the former of each pair is damaged more by the predator than the latter. In July both the Aghani and Katki crop infection takes place more or less side by side ; though the Katki generally gets an advance of about a week or so, yet the Aghani seems to be attacked more by the predator than the Katki. Of the Baisakhi and Jethwi crops the former reaches the male emergence stage, when the parent brood of the latter is being collected and infected, and the former by virtue of its advanced growth is more favourable for the attack of the predator, which emerges in large numbers from the mature Aghani, than is the Jethwi which is settling just then. Thus the Aghani is responsible for the greater attack of the Baisakhi crop, which can be prevented to a great extent, if the control measures recommended in this paper be adopted. The tables also show the relative dominance of the stages of the predator and thereby give a rough idea of the possible number of generations and emergences in a year. This becomes simpler to conclude when the comparative rise and fall of the unhatched eggs, larvae, full pupae and empty pupae are taken into consideration. All of these may not be found corresponding to this effect in some months, because much depends on the samples collected for the examination, but, even, if any two of them correspond, one can certainly get an idea about the approximate time of the presence of adults in the field ; e.g., in table 3 the rise of unhatched eggs and larvae in August shows the presence of adults in large numbers during the month, and the presence of full and empty pupae, also goes to support the conclusion that the first generation of the predator is emerging in this month. In September the fall in the number of unhatched eggs and larvae shows the absence of the adults in the field, and the rise in the number of the full pupae supports this, but one may say that the rise in the empty pupae goes against this. This objection falls to the ground, if one bears in mind that much importance cannot be attached to the number of empty pupae after the emergence of the first generation, because the empty pupae will remain in the incrustation, unless removed, and it is not easy to distinguish the empty pupae of one generation from those of another. In October, again, there is a rise in the number of the unhatched eggs and larvae, and fall in full pupae ; this shows the abundance of the females in the field and supports the view that the second generation has emerged. The remaining four months—November, December, January and February—show the presence and emergence of the third generation in the Aghani crop. Table No. 4 shows the presence of the full and empty pupae for the first time in the Baisakhi crop in March ; this shows that the third generation eggs which were laid in the winter months emerge as adults in this month. In May again there is a rise in the number of full pupae and the presence of empty pupae in the Jethwi crop, this shows the emergence of the fourth generation. The fall in the number of larvae and the rise in the number of full pupae and empty pupae in June, show the emergence of the fifth generation. The rise in the number of unhatched eggs, larvae, full and empty pupae in July, shows the emergence and nearing of the emergence of the sixth generation.

Storage of lac.—Mature and immature scraped lac was caged in parasite cages to find out the emergence of adults during the various months. The results are given in Table Nos. 5 and 6, reduced to per lb. of scraped lac.

TABLE 5.

Aghani in ordinary type ; Katki in **bold**. (Immature to mature fresh).

Date of caging	August	September	October	November	December	January	February	March	April
20–8	**...**	**30·2**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
3–9 } 24–9 }		693·7	22·7	283·0	80·9	8·9	8·9	17·8	...

TABLE 5—(*contd.*)

Aghani in ordinary type ; Katki in **bold** (Immature to mature fresh)

Date of caging	August	September	October	November	December	January	February	March	April
18–9, 24–9, 30–9		**0·5**	**23·0**	**29·5**	...	...	...	...	...
23–10			...	2·6	26·0	18·0	144·0	127·4	...
7–10, 30–10			**28·0**	**55·0**	**26·5**	**12·4**	...	...	...
26–11				...	...	48·4	72·8	...	...
7–11				**20·0**	**73·9**	**5·0**	**3·9**	**2·6**	...
22–12					...	44·0	276·6	8·0	...
31–1						...	2·0	6·0	...
1–2, 8–2, 19–2							2·8	16·0	1·7

TABLE 6.

[Jethwi in ordinary type ; Baisakhi in **bold.** (Immature to Mature fresh)].

Date of caging	December	January	February	March	April	May	June	July	August	September
7–12	...	...	...	...	...	...	...	..	...	...
9–1		...	...	...	...	...	...	...	...	...
22–2			...	...	...	...	...	...	...	...
14–3				...	**4·0**	...	...	...	...	...
9–4					**56·6**	**14·6**	...	...	...	...
25–4					...	...	...	...	...	...
3–5, 19–5						**158·5**	**192·5**	**22·6**	...	...
21–5						...	181·2	...	...	...
18–6, 28–6							...	...	...	...
25–6							26·6	293·3	53·3	...
4–7, 11–7, 21–7								**2·9**	**2·9**	**0·65**
11–7, 18–7								15·6	134·0	...

Table Nos. 5 and 6 show the overlapping of the broods, and the preponderance of the predator in the Aghani and Katki over the Jethwi and Baisakhi. And also that the Aghani is attacked more by the predator than the Katki. Some of the eggs laid in September hibernate in larval condition and emerge at different periods till March. Till February the Baisakhi brood does not suffer much from the attack of the predator.

Hibernation.—

The predator hibernates more or less in the larval stage mostly from about the middle of November till the first half of February. The larvae at this stage do not seem to do much damage and lie concealed below the encrustation over the stick.

Distribution.—

The moth is widely distributed all over the country. It has been reared at Namkum from lac received from Halimahat, Sonapur and Palas Bari (Assam), Ranchi, Daltongunj, Pakur, Pusa (Behar), Mathurapur, Nimtita and Raghunathgunj (Bengal), Benares (U. P.), Damoh, Raipur, Kota Bilaspur, Jubbulpur (C.P.), Panna State (C.I.), Hyderabad-Deccan, Kashmir, Jodhpur (Rajputana), Minbu (Burma), Sind and Bangalore (Mysore), Dharwar, Bijapur, Bombay. Other workers on the lac insect have also reported it from Kumaun Division, Dehra Dun, Kheri (U. P.), Aramboly (S. Travancore), Ceylon, Khandesh Forests, Bombay.

Economic Status.—

It does more damage to the lac insect than any other single species of injurious insect. At least 30% of the damage is done by this predator alone. A single larva damages from 40-45 mature cells prior to pupation. It not only destroys the lac insect but also eats the lac incrustation.

Natural Enemies.—

Known :

1. *Bracon tachardiæ* :—Parasitises the *Eublemma* larva. The larva feeds externally on the *Eublemma* caterpillar.
2. *Chalcis tachardiæ* : larva is an endoparasite of the *Eublemma* pupa.
3. *Camponotus compressus* (the big black ant) and *Solenopsis geminata* pick up *Eublemma* larvae when they come out from the egg shells and are trying to enter lac cells by biting at the encrustation.
4. *Ephestia* sp. Mainly a scavenger, but its larva always attacks *Eublemma* larvae and pupae when it comes in contact with them while entering into the galleries of *Eublemma*.

Suspected :

1. A black braconid (unidentified).
2. A Chalcid fly *Elasmus claripennis* Cam.[1]

Control measures.—

The control measures can be broadly divided into physical and chemical The following two of these, as the experimental data in table 7 shows, have been found useful and may well be used by a poor as well as by a rich cultivator according to his means.

THE EFFECT OF FUMIGATION AND KEEPING THE STICK LAC UNDER WATER.

TABLE No. 7.

—	Wt. of scraped lac in lbs.	Total emergence		Total
		Eub.	Other insects.	
Fumigated	47·18	...	86	86
Control	46·99	662	11,265	11,927
Stick lac kept under water.	19·58	1	20	21
Control	16·89	300	3,720	4,020

[1] *Elasmus claripennis* Cam. has definitely been proved an ectoparasite of the *Eublemma* larva after this paper had been sent for publication.

1. *Physical.*—

(i) The whole crop excluding the portion intended to be used as brood lac should be kept immediately after reaping under water from 6–10 days, and then taken out and allowed to dry completely preferably in the shade. If the sticks be now examined, not a single living predator or parasite or lac insect will be found on the sticks. The crop can then be scraped and sent for sale in the market. If the days are not sunny when the operation is performed, the sticks can at a small cost be completely dried by placing them over hot sand.

(ii) Selected, and as far as possible, predator and parasite free brood should be used for every crop. Self-inoculation should be avoided.

(iii) Kusum brood should be avoided to inoculate any other host but Kusum for the Katki crop because Kusum brood and its progeny matures in January-February which means destruction of more lac insects and of lac resin by the predators and parasites and multiplication of predators and parasites.

Troup has suggested burning the lac sticks attacked with *Eublemma* and other predators. This is not advisable at all and always means a loss.

2. *Chemical.*—

The whole crop excluding the portion to be used as brood after reaping should be fumigated with (CS_2) Carbon bisulphide or Hydrocyanic acid gas, preferably the former, as it is less dangerous and can be operated by a person of average intelligence who need not necessarily have a scientific training. After charging the chamber with Carbon bisulphide, it should be left closed for 24 hours, and then opened. The details of the fumigation can be taken from any book on insecticides or from *Pusa Bulletin* No. 185, pp. 113–14. The dose should be one ounce of Carbon bisulphide for every 10 cubic feet of space.

The portion of the crop which has been used as brood should also be removed soon after the lac larvae have swarmed and treated in the same way. If all cultivators will only follow either of the above measures, they will be adding at least one-fourth more to their crop in every season, because the number of predators and parasites of the lac insect is bound to decrease every season with these measures.

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SUMMARY

Eublemma amablis is a Noctuid moth predaceous on the lac insect. It does more injury to lac than any other single species of predator and parasite of lac. It has six generations in a year, and does more injury to the Katki crop (Aghani and Katki) than to the Baisakhi (Jethwi and Baisakhi). The predator has several natural enemies. It can be usefully controlled by either Physical or Chemical measures.

Physical measures.—(1) The portion of the crop used as brood lac for infecting the plants should be kept under water from 6–10 days immediately after all the lac insect larvae have emerged from it and the rest of the crop should be similarly treated immediately after it has been reaped. (2) Selected and as far as possible, parasite and predator free brood should be used for every crop. Self-inoculation should be avoided. (3) Kusum brood should be avoided to inoculate other host plants excepting Kusum for the Katki crop. This will save the destruction of the lac insect by predators and parasites for a further three months, i. e., November-January, and also check the further multiplication of the predators and other injurious insects, and their attack on the Baisakhi and Jethwi crops.

Chemical measures.—The portion of the crop as suggested above should be fumigated with Carbon bisulphide at the rate of 1 ounce of Carbon bisulphide to 10 c. ft. of space.

With these measures alone, the cultivator is sure to raise his yield of lac by about one-fourth in each crop.

EXPLANATION OF PLATES

PLATE I.

Eublemma amabilis. Fig. 1 Male. Fig. 2 Female.

PLATE II.

Fig.

3. Head with mouth parts of female × 25.
3*a*. A portion of the eye highly magnified.
3*b*. Labial palp × 100.
3*c*. Proboscis × 150.
3*d*. Basal joint of antenna × 200.
3*e* Apical joint of antenna × 150.
3*f*. One of the middle joints of antenna × 350.
4*a*. Venation of fore-wing × 12.
4. Venation of posterior wing × 12.
6. Freshly laid egg × 120.
6*a*. Nearly mature egg × 120.
6*b*. Larva coming out of the egg × 120.

PLATE III.

FIG.

5. Male external genitalia × 40.
7. Newly hatched larva × 200.
8. Mature larva × 15.
8*a*. Mouth parts of larva excluding mandibles and labrum × 100.
8*b*. Head of mature larva × 15

PLATE IV.

FIG.

9. Alimentary canal of larva and its appendages × 12.
10. Salivary glands of larva and their ducts × 48.
11. Silk glands of larva × 48.
12. Nervous system of larva × 15.

PLATE V.

FIG.

13. Tracheal system of larva. Dorsal integument and viscera removed × 15.
14. Second abdominal spiracle of pupa from outside after dechitinisation × 400.
15. Second abdominal spiracle of adult from inside after dechitinisation × 400.
15*a*. Prothoracic spiracle of adult side view after dechitinisation × 400.
16. Abdominal spiracle of larva after dechitinisation from outside × 400.
17. Female pupa—dorsal view × 12.
18. Female pupa—ventral view × 12.
19. Male pupa—ventral view × 12.

GLOSSARY

AGHANI ... Lac crop progeny of pure Kusum brood infected in June-July, matures in January-February.

BAISAKHI ... Lac crop progeny of other broods than pure Kusum infected in October-November, matures in June-July.

BER ... Zizyphus Jujuba.

JETHWI ... Lac crop progeny of the Kusum brood infected in January-February, matures in June-July.

KATKI ... Lac crop progeny of other broods than Kusum infected in June-July, matures in October-November.

KHAIR ... Acacia catechu.

KUSUM ... Schleichera trijuga.

PLAS ... Butea frondosa.

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REFERENCE LETTERING TO PLATES I–V.

a	...	Clypeus.
A_1, A_3	...	Anal veins.
ab.	...	Abdomen.
a. bc. & a. o.	...	Common aperture of bursa-copulatrix and oviduct.
ab. g.	...	Abdominal ganglia.
a. c. e.	...	A part of the compound eye.
a. f. a.	...	Adfrontal area.
am.	...	Ampulla.
an.	...	Anus.
ant.	...	Antenna.
ap. ant.	...	Apical Joint of antenna.
b. ant.	...	Basal joint of antenna.
br.	...	Brain.
c.	...	Epipharynx.
c. e.	...	Compound eye.
cl.	...	Clasper.
cv.	...	Clavus.
cu_1. cu_2	...	Cubitus.
D. dt.	...	Transverse dorsal trachial tube.
dv. l.	...	Developing larva.

E.	... Egg.
e.	... Proboscis.
em. l.	... Emerging larva.
ep.	... Epicranium.
F.	... Fore-intestine.
Fr.	... Furculum.
fr.	... Frons.
fr. cl.	... Fronto-clypeus.
G.	... Inner groove of proboscis.
g.	... Spinneret.
ga.	... Male genital aperture.
H.	... Head.
Hi.	... Hind-intestine.
J.	... Juxta.
K.	... Cremaster.
lb. p.	... Labial palp.
lbr.	... Labrum.
L. dt.	... Lateral trachial tube.
lg_1-lg_3	... Leg.
LI	... Prementum.
LM	... Maxillary lobe.
M.	... Midintestine.
M_1-M_3	... Media.
md.	... Mandible.
md. ant.	... Middle joint of antenna
MI.	... Mentum.
mi.	... Micropyle.
mt.	... Malpighian tube.
mxc.	... Maxillary cardo.
mx. p.	... Maxillary palp.
mx. s.	... Maxillary stipes.
N	... Palpiger.
n. f.	... Nerve fibre.
OC	... Ocelli.
p.	... Peniculus.
pi.	... Pilifer.
pl.	... Proleg.
Q.	... Submental sclerite
R-R_5	... Radius.
r.	... Rectum.
R. F.	... Rudimentary Filippi's gland.
s. a.	... Spinning apparatus.
$Sc._1$, Sc_2	... Sub-costa.
Sc. S.	... Sacculus.
S. d.	... Salivary duct.
S. G.	... Salivary gland.
s. g.	... Silk gland.
sp.	... Spiracle.
T. g.	... Thoracic ganglia.
Th.	... Thorax.
Tl.	... Thoracic leg.
T. V. dt.	... Transverse ventral trachial tube.
U.	... Excretory chamber.
Un.	... Uncus.
V.	... Vinculum.
v. n. c.	... Ventral nerve cord.
W.	... Wing.

THE FLOWERING OF BAMBOOS

BY

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PART III

(*Continued from page* 141 *of this volume.*)

SOME MORE SPECIES WITH IRREGULAR FLOWERING

Arundinaria falcata Nees is the low level Ringal of the N. W. Himalaya. Brandis is positive that it belongs to the irregularly flowering bamboos. Sometimes it is found flowering sporadically, at other times it flowers gregariously over large areas. In 1886 it was in flower all over the hills of Jaunsar and Tehri Garhwal and almost every culm was loaded with flowers (A. F. Broun). Gamble frequently found it in flower and though 'as happened in 1879, years of general seeding are of occasional occurrence, a few clumps may be in flower in almost any year.' It is interesting to note that a variety of *A. falcata*, viz. *glomerata* flowers almost every year at Kew on a certain number of culms.

Of *Arundinaria Falconeri* Benth. and Hook. growing at Kew, Bean says that the flowering is not simultaneous in the sense that plants in various places, or even in the same place, flower during one summer. Although the general flowering may occur in one particular year, it is heralded by the flowering of a few forerunners the previous year and followed by that of laggards the next. *Arundinaria spathiflora* flowers sporadically and probably gregariously every 10 years. *Dendrocalamus longispathus* Kurz whilst flowering gregariously is often found flowering sporadically. *Neohouzeaua stricta* Parker behaves in the same way. In all probability *Ochlandra travancorica* Benth should also be put in this class.

There are a good many bamboos of which we don't know whether they belong to the class showing gregarious, periodical, or irregular flowering.

Bambusa nutans Wall., e.g., according to Gamble 'seems to flower only at long intervals' and Parker says it flowers 'periodically at long intervals'. We have 3 records from Dehra Dun : 1840, 1893 and 1894. Are they complete? If we are not sure of it, it will not be easy to insist on periodical flowering at long intervals.

The records of flowering of this class seem to be still less satisfactory than they are of gregariously flowering bamboos. We must admit that it is more difficult to find out, e.g., whether an isolated clump which flowers sporadically is of the same age as those bamboos by which it is surrounded, but which are not in flower.

THE DEATH OF RHIZOMES AFTER FLOWERING.

It was stated above that in bamboos flowering annually the plant does not die after flowering. With regard to bamboos flowering gregariously and periodically we mentioned that after ripening the seeds the culms die and with them as a rule the rhizomes. These are, therefore, exceptions. Broun mentions that most clumps of *Bambusa arundinacea* Willd. growing at Dehra Dun died down immediately after flowering in 1881. But in 1882 one clump produced a number of new stems and these flowered again during 1886 and there was no sign at the time of new leaf-bearing culms shooting up. Another case is mentioned by J. Nicholls (*Ind. For.* xxi, 92). In a general flowering in 1885 the same bamboo in the upper valley of the Mahanadi river had died off, but 'here and there was to be seen an exceptional stalk, and a few attenuated and almost abortive shoots had sprung up from moribund roots. These were striving to "flower and seed."' These, however, are exceptional cases.

There are many records to show that generally the whole plant dies. Wallich, in a report to Government in 1825 when speaking of the famous bamboo grove which surrounded the city of Rampur, in Rohilkhand, makes these remarks : 'I had heard a great deal about this unique object, and was, therefore, the more solicitous to collect all the information I could on the spot. It has been in a state of universal blossoming in 1824, so universal that there was not among its millions of stems a single one to be seen which was not dead, they were all leaning on each other or fallen to the ground.' [*Ex Agric.* and *Hort. Soc. Ind.* xiii, pt. i (1863-64) *Proceed.* lv]. Spilsbury mentions in 1842 that all the bamboos from Jubbulpore to Mundlah having seeded in 1839, had died shortly afterwards. According to W. H. Sleeman, in 1836 all the large bamboos 'whose clusters and avenues have formed the principal feature in the beauty of Dehra Dun, ever since the valley became known to us, or for the last quarter of a century, have run to seed and died this season : as well those transplanted from the original stock last season as those transplanted twenty years ago'. Buchanan in his Journey from Madras through Mysore, Canara and Malabar (1807) writes about the Anamalay bamboo : 'Here are both the hollow and the solid kinds. When fifteen years old they are said to bear fruit and then to die.' The testimonies as to the wholesale destruction of bamboos after flowering are numerous.

The case is different in irregularly flowering bamboos. Here the rhizome often remains alive. T. Anderson, formerly Superintendent of the Botanical Gardens in Calcutta, states 'that in 1857 and 1858 many of the bamboos near Calcutta and on Parasnath flowered and seeded, but in no case that he was aware of, did a general death of the bamboo follow.' So far as he observed, only the flowering shoots died; and their place was taken by young shoots springing from the roots; but during the flowering and seeding the foliage almost entirely disappeared. He adds that when the *Bambusa gigantea* [*Dendrocalamus giganteus* Munro] at Calcutta, after thirty years, flowered for the first time in 1861, although weakened, remained alive.' (*Munro Monogr. Bambus*, 3). Anderson includes in the above statement *Bambusa Tulda* Roxb., *Dendrocalamus strictus* Nees, *Dendrocalamus giganteus* Munro and perhaps also *Dendrocalamus strictus* var. *sericea* Gamble from Parasnath. *Arundinaria falcata* Nees is an irregularly flowering bamboo, but its variety *glomerata* flowers at Kew almost every year on a certain number of culms, but the plant as a whole does not suffer (Bean). Of *Arundinaria Falconeri* Benth. & Hook., introduced from India into Europe and Algeria, nearly all the plants flowered there and died. *Arundinaria hookeriana* Munro flowered in England in 1899. All the Kew plants died, whilst at Glasnevin some died, others recovered. *Arundinaria Maximowiczii* Hort. flowered in the Bamboo Garden of Kew in 1896 all over the plant and died in 1897. Of *Arundinaria Simoni* A. & C. Riv. odd culms flowered and died in 1892, but the plants were not affected. Every culm of the same bamboo flowered in the Temperate House as well as in the Bamboo Garden in 1903-05, seeded and died. In 1874 large tracts of *Cephalostachyum capitatum* Munro in the Chel and Neora valleys in British Bhutan flowered and died off (Gamble). *Dendrocalamus Brandisii* Kurz is said to flower sporadically and not to die off after flowering, but Oliver says that flowering clumps which he has observed showed every appearance of being about to die (Gamble). *Phyllostachys puberula* Mak. flowered at Kew in the Temperate House in 1902 and in open air from 1903-05; all plants died. A variety of the same bamboo var. *Boryana* H. de L. flowered at Kew in 1904. The whole plant died with the exception of a small portion.

As to *Arundinaria nitida* Mitford, the most beautiful of all hardy bamboos cultivated in Europe, E. Bretschneider wrote to Kew in May 1898 [see *Kew* Bull. (1898) 316] : M. Berezovski who belonged to both of Potanin's expeditions to S. W. Chima (1884-86 and 1892-95) reports that in 1886 the bamboos all round in the country (S. Kansu) flowered. People said that the bamboo flowers only once in 100 years and that old men remember having heard from their grandfathers that it flowered and seeded. In one case it seeded abundantly. After seeding all the plants died, and even the roots.

How do Offsets behave?

When answering this question we have to distinguish the vegetative from the flowering phase of the bamboos.

(*a*) *The vegetative phase.*—Cuttings taken from an old clump, let us say, of *Bambusa arundinacea* Willd. or some similar bamboo, will, when planted out, behave in the same way as seedlings. Only thin whip-like shoots will grow for a number of years and then a full-sized stem is developed, which attains its full height generally in a few weeks. The sheaths at the nodes are dry and leathery and only a few green leaves are developed at the top. The branches appear several months later. S. E. Peal (*Ind. For.* viii, 50) mentions offsets taken from *Bambusa tulda* Roxb., a bamboo of Bengal, Assam and Burma. Peal observed in Assam that the first whips may be 16 ft. high and 1 inch thick and solid in the second year; in the third year the shoots run up 30 ft., showing a diameter of 1½–2 inches, while in the fourth season the shoots often reach full size.

There are other bamboos, however, whose offsets take a much longer time to produce full-sized shoots. But all agree in this that offsets behave like seedling plants regarding the production of full-sized culms. Apparently the rhizome must reach a certain dynamical stage before it can throw up full-sized stems.

(*b*) *The flowering phase.*—Here the offsets behave quite differently from seedlings.

According to Brandis (*Ind. Trees* (1811) 662) 'offsets taken from a clump some time before it flowers come into flower at the same time as the parent clump.' Troup (*Silv. Ind. Trees* ii (1921) 993) is less definite on this point. He only asserts that clumps resulting from cuttings or by other vegetative methods of reproduction 'are liable to flower when the parent clumps flower, and their life may be short or uncertain'. The *Indian Forester* (ii, 311) mentions a case of *Dendrocalamus Brandisii* Kurz (Brandis thinks that it is possibly *D. giganteus* Munro) which is evidently an exception to Brandis' rule. Villagers in the Irrawaddy Delta estimated the age of flowering of that bamboo at 40 years. In order to protect the bamboo resources of the whole area, they plant offsets at the beginning of the rains; here the rhizomes of both bamboos are of the same stock, but it has been found that the mother plant will flower and die in due time, whilst the daughter culms will flower long after. They reach maturity after 15 or 16 years. Troup mentions that offsets taken from *Dendrocalamus giganteus* Munro flower later than the parents. Henkel has observed in S. Rhodesia that plants reproduced from branches of the rhizome flower and die at the same time as the parent plant.

The question, therefore, as to the flowering of offsets has not been definitely settled. Experimental work alone can lead to conclusions which would be interesting not only from a theoretical but also from an economical point of view.

Does Mutilation of Clumps Produce Flowers?

When treating of *Bambusa tulda* Roxb. Gamble (*Bambus. Brit. India* (1896) 31) says: 'As regards its years of flowering, it undoubtedly has the habit of flowering gregariously over considerable areas, but single clumps, as has been observed in the Royal Botanic Garden of Calcutta, if badly treated by over-cutting or partly uprooted, will often produce flowers without any general flowering.' He mentions the case of a clump of that bamboo which was blown down near Calcutta in 1892. The rhizomes were torn from the ground and the stems mostly cut. A year after many thin twigs with flowers were produced from the rhizome, which, however, did not yield perfect seed. The last general flowering in Lower Bengal took place in 1884. Of *Bambusa nutans* Wall. a clump was found near Dehra Dun in 1893 with the rehizome exposed and the culms cut off. The flowering twigs produced at the time flowers, but perfect seed was not developed. Here the last periodic flowering went back to 1840. It will be useful to remember that in 1894 Gamble observed another clump in flower which had not been mutilated before. Brandis suspects some analogy between the behaviour of mutilated bamboo clumps and apple trees which are being slashed in European gardens in order that they may produce fruit more freely. Kurz, on the other hand, remarks that it is customary in some bamboo plantations to cut down all the stems the year before flowering is expected in order to prevent flowering (*ex* Troup). Here is another wide and fascinating field for experiments.

Do Seedlings Occasionally Flower?

The *Ind. For.* (xxv, 1899, p. 22) reproduces a report of the Conservator of Forests, Patiala State, on seedlings of *Dendrocalamus strictus* Nees. Seed was gathered in June 1894 from natural bamboo forests growing on South or S. E. slopes of dry, stony, lower hills of Sub-Himalayan tracts, 1-6 miles to the N. W. of Kalka, at an altitude of 2-3,000 ft. About 15 seers of the seed was sown in State Forest nurseries at the beginning of March 1895. In February 1896 all the seedlings were transplanted into baskets and in April of the same year five seedlings began to flower. Two plants were sent to Dehra Dun and three were kept at Pinjour where they died within 3 or 4 months. Brandis, who saw the Dehra Dun specimens, says that the rhizome was strongly developed. On one side were the stumps of two primary shoots which died and dried up. At the end of one bent rhizome branch was the first stem, bearing flowers instead of leaves. The flowers were perfectly formed, generally 2 fertile ones in 1 spikelet; the 6 anthers were full of pollen and in the more advanced spikelets the ovary was stout, the ovule, to all appearance, having been fertilized. Nothing is known about the seeds.

Brandis (*Ind. For.* xxv (1899) 23) regrets his inability to explain this 'entirely exceptional and most remarkable case.' 'So much, however,' he says, 'we may learn from it, that the action of the leaves on these five plants during the rains of 1895, was sufficient to create in them the disposition to form flower-buds in the place of leaf-buds, for the ends of the flowers which began to show themselves in April 1896, must have been formed in the previous autumn.' But we should like to know why the action of the leaves was sufficient to create that disposition in this case, and why not always. If the Conservator's report gave us some more details regarding the exact treatment of the seedings and the different climatic conditions prevailing in the place of seeding (1-6 miles N.W. of Kalka) and the place of the forest-nurseries (3½ miles S.E. of Kalka), we might be helped in forming some hypothesis.

Troup mentions that instances of the undoubted flowering of bamboo seedlings have been observed from time to time, but these, he says, 'are mere abnormalities.' As long as we are not able to explain the normal, it is useless to tackle the abnormal.

Is Seed from Sporadically Flowering Clumps Inferior in Quality?

J. W. Oliver mentions that *Cephalostachyum pergracile* Munro may be found almost any year flowering sporadically, but not generally producing good seed on such occasions. *Dendrocalamus strictus*, says Gamble (*Ind. Bamb.* 79) 'may be found flowering sporadically, a few clumps at a time, almost every year, in any locality. . . . . These flowerings, however, do not produce as much good seed as when the gregarious flowering takes place.' J. W. Oliver asserts the same of *Dendrocalamus Hamiltonii*. In his *Introduction to the Ind. Bamb.* (p. viii) Gamble makes the general statement: 'Even in those kinds which may be found occasionally in flower sporadically general flowerings also take place, and at these the seed produced is usually good, while that given in the sporadic flowering is often poor and of small quantity.' Brandis (*Ind. For.* xxv, 17) calls this a 'remarkable and important point.' He thinks that foresters would do well to make methodical experiments and he advises the determination of the weight and the percentage of germinating seed of each species of general and sporadical seedings. Troup, however, is of a different opinion. 'The seed from sporadically flowering clumps,' he remarks, 'is said to be not always so fertile as that produced at the time of gregarious flowering; this, however, does not appear to be a general rule, since seedlings of several species have been raised from seed obtained from solitary flowering clumps, and natural seedlings have been observed in plenty round such clumps in the forest.' (*Silvic. Ind. Trees* iii, 982.) These are two contrary views of two able men, but neither view can claim the confirmation of experiment. If Troup has observed natural seedlings in plenty round such clumps after sporadic flowering, he does not tell us how many seeds did not germinate. In the meantime we must remain neutral till experimental proofs are forthcoming.

Does the Absence of New Culms Indicate Flowering in the Following Year?

When Brandis witnessed the first general flowering of bamboos in Pegu, his Burman friends stated that such an event could be foreseen with certainty, for during the year preceding the flowering no new culms were formed. (*Ind. For.* xxv, 20). This opinion is, apparently, generally accepted in Burma. Brandis did not further follow up the question and, as far as my knowledge goes, we have no data from other parts of India. Troup, however, states that it has actually been observed not only in the case of clump-forming bamboos, but also in the case of the single-stemmed bamboo, *Melocanna bambusoides*. This is another point which can only be cleared up by prolonged and detailed observations.

Flowering of Bamboos Cultivated in Europe and N. Africa.

On this question there are few records and most of those that are at our disposal are very incomplete and unsatisfactory. It is not enough to know that a certain bamboo flowered in Europe in a certain year. We want to know when the plant was introduced into a certain country, where the plant came from, e.g., whether from the Himalaya or from the plains of India, how it was introduced, whether by seed or by cuttings, whether it was kept in the open or under shelter. It would also be interesting to know whether seeds (perfect or imperfect) were produced, whether the seeds germinated spontaneously or under special care, what became of the flowering culms and of the rhizome, whether the plant died after flowering either wholly or partially, etc. The answers to these questions might help in the solution of the numerous problems presented by this class of bamboos and especially of the periodicity of flowering.

Whatever information I have been able to gather is given in the following table. The species are arranged alphabetically. The following abbreviations will be used: B. G. = Bamboo Garden. T. H. = Temperate House. What we know regarding the behaviour of cultivated plants in India will be discussed later on.

FLOWERING OF CULTIVATED BAMBOOS IN EUROPE AND N. AFRICA

Species	Indigenous in	From where introduced	As seed or offset	Date of introduction	Flowered in	Date of flowering	Seeded	Authority	Notes
Arundinaria falcata Nees.	India ...	...	...	...	Europe ...	1866–67	...	...	...
				About 1840	Angers, Nantes, Hamma.	1875	...	Brandis.	...
					Paris ...	1876	...	,, ...	Flowered at Kulu in 1876.
					Kew (T.H.) ...	1884	...	Bean ...	Flowered in several other places about the same time
,, ,, var. *glomerata*	,, ...	...	...	...	Kew (T. H.) ...	Almost every year.	...	,, ...	Plant as a whole does not suffer.
,, *Falconeri* Benth. & Hook.	,, ...	India ...	Seed.	1847 ...	Trentham ...	1875	...	...	...
					Kew, Irish and Cornish Gard.	1876	All produced perfect seed.	Bean ...	All plants died. General flowering in Sikkim in 1876.
					Algeria ...	1876	...	,, ...	...
					Holland House.	1877	...	,, ...	...
					Kew ...	1893, 1894	...	,, ...	Odd culms flowered.
					Hollycomb ...	1903	...	,, ...	...
					Frensham Hall.	1904	...	,, ...	...
					Derreen, Kenmare.	1906	...	,, ...	...
					Europe ...	1908, 1909	...	H. de L	...
,, *Hindsii* Munro.	E. Asia..	...	...	...	,, ...	1910	...	,, ...	...
,, *hookeriana* Munro.	Sikkim, Bhutan.	...	...	...	Kew (T.H.) ...	1899	Seeded.	Bean ...	All plants died.

,, *intermedia* Munro.	Sikkim, Assam	...	...	...	Glasnevin ...	1899	...	,, ...	Some plants died.
					Kew (T.H.) ...	1899	...	,, ...	Died.
					Europe ...	1907	...	Camus...	...
					,, ...	1910	...	H. de L.	...
,, *khasiana* Munro.	Khasia Hills.	...	...	...	France ...	1905	...	Camus...	...
,, *Maximowiczii* Hort.	Japan ...	...	...	...	Kew (B.G.) ...	1896	...	Bean ...	Flowered all over the plant and died in 1897.
,, *racemosa* Munro.	Sikkim...	...	...	...	Kew (T.H.) ...	1899	...	...	...
,, *Simoni* A. & C Riv.	China ...	China ...	...	1862 ...	Belgium ...	1876	...	Camus...	...
					Kew (B.G.) ...	1892	...	Bean ...	Odd culms flowered and died; plants survive.
					,, ,, ...	Every year from 1893–1902	...	,, ...	Flowered in the same way.
					Kew (T.H.) ...	1903	Seeded.	,, ...	Every culm flowered, seeded and died
					Kew (B.G.) ...	1904–5 ...	...	,, ...	Every culm flowered and whole plant died.
					Europe ...	1910 ...	...	H. de L.	...
Arundinaria Simoni var. *variegata* Hook. f.	China ...	China ...	...	...	Kew ...	1877 ...	...	Bot.Mag.	Flowering partial or complete?
,, *variabilis* Mak. var. *Fortunei*.	...	...	...	...	Europe ...	1902–5 ...	...	Camus...	...
					,, ...	1906, 1910	...	H. de L	...
Bambusa nana Roxb. ...	China, Japan.	...	...	...	Kew ...	1893 ...	...	,, ...	Flowered in Japan in 1893
Bambusa nana var. *Alphonse Karri* M.	...	...	...	...	France ...	1908, 1910	...	H. de L.	...
,, var. *gracillima*. M,	...	...	...	...	Europe ...	1911 ...	...	,, ...	...

FLOWERING OF CULTIVATED BAMBOOS IN EUROPE AND N. AFRICA—(*Continued*).

Species	Indigenous in	From where introduced	As seed or offset	Date of introduction	Flowered in	Date of flowering	Seeded	Authority	Notes
Chusquea abietifolia Griseb.	Jamaica	Jamaica.	...	...	Kew, Palm House.	1884 ...	Seeded	Bean ...	In the same year general flowering and death in Jamaica.
Oxytenanthera albociliata Munro.	Burma...	Burma...	...	...	Europe ...	1909 ...	...	H. de L.	The nearest general flowerings in Burma were from 1911—1914.
Phyllostachys aurea Carrière	China, Japan.	...	...	...	Florence ...	1876 ...	...	Bean ...	...
					Belgium ...	1904 ...	...	Camus...	...
					Rossdohan, Kerry.	1905 ...	...	Bean ...	...
,, *bambusoides* var. *Castilloni.*	China ...	China ...	...	...	Kew ...	1903 1904	...	Camus...	...
,, *flexuosa* A. & C.Riv.	,, ...	,, ...	...	1864 ...	Hamma ...	Feb. 1876	...	Brandis.	Osbeck remarks that it is said to flower once in 60 years.
					Toulon ...	May 1876	...	...	...
					Paris ...	July 1876	...	...	...
,, *mitis* Riv. ...	,, ...	,, ...	...	1856 ...	Algeria ...	1857 ...	...	H. de L	...
,, *nidularia* Munro.	Japan ...	Japan ...	...	...	Florence ...	1887 ...	...	,, ...	...
,, *puberula* Mak.	,, ...	,, ...	...	...	Sussex ...	1898 ...	...	Bean ...	...
					Cornwall; near Bristol.	1900 ...	...	,, ...	Flowered in Japan in 1900.
					Kew (T.H.) ...	1902 ...	...	,, ...	...
					Kew, open air...	1903, 1905	...	,, ...	None of the plants recovered.
					Europe ...	1906 ...	...	H. de L.	None of the plants recovered.

,, ,, var. *Boryana* H. de L.	...	...	...	...	Exeter ...	1903 ...	...	Bean ...	...
					Kew ...	1904 ...	...	,, ...	Entire plant died, excepting a small portion.
,, ,, var. *fulva* H. de L.	...	...	...	...	,, ...	1905 ...	...	,, ...	...
,, ,, var. *nana* H. de L.	...	...	...	...	,, ...	1904 ...	...	H. de L.	...
,, ,, var. *nigra*.	...	...	...	1827	Kew, Abbotsbury, all over Europe.	1900 ...	...	Bean ...	Flowered in Japan in 1900.
Sasa auricoma E. G. Camus.	Japan? China?	...	...	...	Kew ...	Annually	...	,, ...	Only few culms flower and die; plant not affected.
,, *japonica* Mak. ...	Japan ...	...	Offset.	1850	Algeria, Paris, Marseilles.	1867, 1868	...	Camus...	All offsets of the same parent plant.
					England, Florence.	1872. 1874	...	Bean ...	...

A glance at the above table shows that three columns are almost empty, viz., those which should show whether a bamboo has been introduced as seed or offset, when it has been introduced and whether it seeded. The absence of this information prevents us from drawing a number of conclusions which might have been highly interesting. Still a few points are not without interest:

Arundinaria falcata flowered in Europe in 1875 and 1876, about 35 years after introduction. This would coincide with the flowering at Kulu in 1876 and there is certainly an approach to the long life cycle which has been calculated in this species at 28-30 years. The flowerings at Angers, Nantes and Hamma took place in 1875 and in Paris in March and April 1876. Has the colder climate of Paris to do something with this difference? The flowering of 1884 had been observed not only at Kew but in several other places. What is this uniformity due to? It is strange that the var. *glomerata* flowered at Kew almost every year, without the plant dying down. I suppose this is the sporadic flowering of the species in India. *Arundinaria Falconeri* flowered at Kew and in Irish and Cornish gardens and Algeria, and all the plants died. This seems to correspond with the general flowering of 1876 in Sikkim. When in 1893 and 1894 odd culms flowered at Kew, it must have been a case of sporadic flowering.

The flowering of *Bambusa nana* at Kew took place in the same year as the one in Japan in 1893.

The West Indian bamboo *Chusquea abietifolia* offers a striking instance of simultaneous flowering. A plant was growing in the Palm House at Kew and came into flower and died in 1884. Daniel Morris had observed the general flowering of the same species and at the same time in its native country Jamaica. He wrote in *Gard. Chron.* (1886) 524: 'When the seed was set, the stem began to die down and apparently every plant in the island died, root and all.'

In *Phyllostachys flexuosa* we notice the same difference in the dates of flowering which we observed in *Arundinaria falcata*, and perhaps the same reason, i.e., difference of climate may be given as an explanation. The bamboo flowered at Hamma in February 1876, at Toulon in May, and in Paris in July of the same year. This took place 12 years after its introduction from China in 1864 and, as it flowered in three places at the same time, it almost looks like a general flowering. Osbeck, who gathered this plant during his travels in China in 1751, says (in *Resa* (1757) 204) that it is said to flower once in 60 years. But we have no facts supporting that statement.

Phyllostachys puberula was seen in flower in Cornwall and near Bristol in 1900, the same year when it flowered in Japan, its native country. Its variety *nigropunctata* produced flowers in the same year in England as well as Japan.

Of *Sasa japonica* offsets had been planted in Algeria, Marseilles and Paris in 1850 and all flowered in 1867 and 1868.

On the whole bamboos seem to flower rarely in Europe. Houzeau de Lehaie who since 1883 has observed and studied the bamboos cultivated in Europe and N. Africa wrote in 1910 that he had watched about a hundred species but that only eight had flowered. *Phyllostachys puberula* var. *nigra* was introduced in 1827, but never flowered in Europe till 1900. No botanist had described the flowers before that date. A reintroduction of that variety, dating back to 1846 and widely distributed in Europe, has never been observed in flower.

Of *Phyllostachys mitis*, introduced in 1856, a weak plant flowered the year after at Hamma in Algeria; but the flowers were neither gathered nor described, and up to the present day they are unknown to botanists. No flowering record is known from its native country China. Health and strength of the plant don't seem to have any influence on the time of flowering. It has been growing since 1856 in Algeria and many other places of Africa and Europe, there are weak plants and strong plants, old and recent plantations, but not one plant has come into flower.

In Europe flowering and fruiting often take 2 or 3 years and at times longer. We must not forget, however, that anomalies in flowering are quite common in arborescent plants which have been transported from their native habitat to a country with quite a different climate.

It is a pity, indeed, that we possess so few records of flowering times of those cultivated species in their country of origin. But even the several cases of simultaneous flowering under totally different conditions mentioned above may throw some light on the obscure question of periodicity,

Do Cultivated Bamboos in India Behave Differently Regarding their Flowering from Wild Ones?

Parker (*Punjab Flora*, p. 532) says of *Bambusa arundinacea* Willd.: 'Gregarious flowering is supposed to occur at 30–32 years, but this applies to the plant in its wild state.' He thus seems to imply that the cultivated plant behaves differently. In spite of this he calculated some time ago the period of flowering of the same species from 3 data: 1836, 1881 and 1926 and arrived at 45 years. Now the record of 1881 refers to planted trees only and should not, therefore, have been considered, if Parker thinks that wild and cultivated bamboos show a different behaviour regarding their time of flowering.

As early as 1864 T. Anderson, then Superintendent of the Botanical Gardens in Calcutta, wrote to the Secretary to the Government of Bengal: 'I have the honour to inform you that I possess little information about the periodic seeding of Bamboos. In Bengal there are no extensive tracts covered with bamboos as in Western India, but it is generally believed that even where bamboos have been planted, as for example, near villages in Lower Bengal, the periodicity in flowering occurs as markedly as in the case of the wild plant.'

Gamble introduced many bamboos from Burma into the Forest School Park of Dehra Dun where they are flourishing well in spite of the fact that the climate is quite different from that of their native country. *Bambusa nutans* which is indigenous in Assam is cultivated north-west as far as Kangra. *Dendrocalamus Hamiltonii*, a native of Upper and Lower Burma, is doing well in the much colder and drier climate of the Kangra Valley.

We have even a number of cases which show that bamboos introduced either by offset or seed into localities with different conditions of climate, flower at the same time as the wild plant. Troup mentions the following striking examples: *Melocanna bambusoides* flowered in the Bamonpokri plantation, Kurseong, in 1912–13, at the same time when there was a general flowering of natural plants in Chittagong. *Arundinaria falcata* cultivated at Simla flowered in 1916, simultaneously with the general flowering in the jungles of Jaunsar. *Dendrocalamus Hamiltonii* introduced at Dehra Dun was seen in flower in 1894, which was the time of a general flowering in the Sikkim forests.

Still we are not in a position to draw a general conclusion. It is again the records that are wanting. There is no series of observations of flowering times of bamboos in any garden in India from which we could draw unimpeachable conclusions. And even if we could, then it is more than likely that the flowering records of the wild bamboos will be deficient, because so far in nearly all calculations no distinction was made between wild and cultivated plants. We have to thank Mr. Parker for having drawn our attention to this point and it will certainly help towards scientific accuracy if future records make it clear whether they apply to cultivated or wild plants. This, however, will not always be easy, considering the interference with nature on the part of foresters and horticulturists during a period of over a hundred years.

Gregarious Flowering and Famine.

'A bamboo flowering is an event of rare occurrence and which is supposed to bring in its train all sorts of evil, accompanied by dire distress and famine.' (*Dymock Pharm. Ind.* iii, (1893) 587).

J. B. Jones (*Jour. Agric. and Hortic. Soc. India* xiii, pt. i, *Proc.* lv) assigns to the appearance of seed a certainty of impending famine, for say the Brahmins: 'When bamboos produce sustenance, we must look to heaven for food.' But he adds immediately: 'For the hundredth time, perhaps is Brahminical prescience belied, for never was there a finer crop of rice in the field than in the present season of 1836.'

In the *Highlands of Central India* (1919, p. 85) Forsyth, when speaking of the bamboo, says: 'The rare occurrence of the general seeding of the bamboo forests is a godsend to the aboriginal tribes. . . . An abundant supply of wholesome grain is afforded, not only to the wild tribes but to multitudes of the poorer inhabitants of the open country, and the cities around, who crowd to the spot to obtain their share of the heaven-sent provender. There is a proverb that this occurrence portends a failure of the common food staples of the country: but like many such it has not been verified by experience.'

According to Watt (*Commerc. Prod. Ind.* 108) 'it is an undoubted fact the flowering of the bamboo is decidedly influenced by the causes which bring

about famine, for the providential supply of food from this source has saved the lives of thousands of persons during several of the great famines in India.' Let us see what the facts have to say :

'In the month of February of the year 1812', writes C. Blenchynden, 'a failure occurred in the rice crops in the Province of Orissa. Much distress was the consequence, a general famine was apprehended, and would no doubt have taken place, but for a merciful interposition of Providence in causing a general flowering of all the bamboos of the thorny kind, both old and young, throughout the district..... So great was the natural anxiety that was evinced to obtain the grain that hundreds of people were on the watch day and night, and cloths were spread under every clump to secure the seeds as they fell from the branches.' The bamboo in question was *Bambusa arundinacea* Willd.

On the 10th April, 1864, M. J. Shah Stewart, Collector of Kanara, wrote to the Revenue Commissioner, S. D.: 'I have the honor to report that a very large number of people have migrated from the Dharwar and Belgaum Districts to this (Soopa) Talook for the purpose of collecting the bamboo seeds, which are very plentiful this year. They come from Nepanee, Kittoor, Nurgoond, and the Hooblee Taluks in small parties, and remain for ten days or a fortnight, during which time they collect as much seed as the whole party can carry away. It is estimated that about 50,000 persons have in this manner visited the Soopa Jungles during the present season, including inhabitants of Kanara as well as those belonging to other districts. .... It is calculated that each party takes away enough for home consumption during the monsoon months, and that there is some for sale also.'

Shah Stewart mentions that both the large bamboo (bidurgooloo) [*Bambusa arundinacea* Willd.] and the medium-sized or common bamboo (shiboo) [*Dendrocalamus strictus* Nees] seeded during that season. He was informed that a more general seeding would take place in the year following.

J. J. Gray writes in 1866: In the District of Malda [Eastern Bengal] 'there are at present whole tracts of country in which the bamboo [*Bambusa arundinacea* Willd.] has flowered, and the grain is being sold in considerable quantities in the bazaar. It was selling at 13 seers per rupee..... The bamboo harvest has been quite providential as with present prices, the ryots, in the part of the country where the plant had flowered, were on the point of starving.' Grey was told that the same occurred 40 years ago.

In the following list I have tried to tabulate a number of periodic flowerings which coincided with well-known famines during the last century. The list is far from complete and this for two reasons: As regards the periodic flowerings, we must confess that the records are exceedingly poor; and as to famines, I had only two sources at my disposal: *The Statistical Atlas of the Bombay Presidency*,, 3rd edition, 1925, and the Chronological List of Famines and Scarcities from 1769 up to 1903, contained in Vol. III of the *Imperial Gazetteer of India* (1908).

Considering the scanty records of general flowering, we must admit that this is quite a considerable list and we cannot help thinking that there must be some connection between the flowering of bamboos and famines. The cases of coincidence of the two happenings are too numerous as that they could be ascribed to chance. It will be useful to remember that not everything that is called famine can have a connection with the flowering of bamboos. There was a big famine in the whole Deccan and Karnatak, including Thana and Ratnagiri in 1802-03; but it was caused by the march of the army of Yashavantrao Holkar, plundering villages and destroying standing crops. In 1806 a famine was caused in Kanara by the influx of strangers from Ratnagiri and the Deccan, and by depredation of robbers and the prohibition of grain exports from Dharwar. The famine in Ahmedabad, Kaira and Broach of 1912-13 appears to have been caused by locusts. Similarly a famine may be brought about by rats or floods, or by crop diseases and pests. All these cases cannot be considered at present. We must leave their analysis to our descendants a few thousand years hence when psychology, history, economics and biology have analyzed every event down to the last causes. In the present case, we are dealing only with conditions of climate and soil. Here it is quite possible that the same causes may prevent certain crops from developing and thus inducing a famine, whilst on the other hand they may stimulate the vital energy of the bamboo and thus bring about, as a last effort, the propagation of the species. We shall return to this subject below.

FLOWERING OF BAMBOOS AND FAMINE

Species flowering gregariously	Year of Flowering and Famine	Area of flowering	Area of Famine	Notes
Arundinaria falcata ...	1878	Jaunsar	United Provinces	
Bambusa arundinacea ...	1812	Orissa	Orissa.	
,, ,, ...	1864	Kanara	Kanara, Dharwar, Belgaum	
,, ,, ...	1865	Kanara	Canara, Dharwar	
,, ,, ...	1866	Malda (E. Bengal)	Malda	
,, ,, ...	1870	Jubbulpore	Central Provinces	
,, ,, ...	1878	Kanara, Dharwar, Belgaum	Bombay, Madras	
,, ,, ...	1896	Walayar Forest, Coimbatore	Madras	
,, *Tulda* ...	1884	Lower Bengal	Lower Bengal	
,, ,, ...	1892	Burma	Burma	
Dendrocalamus giganteus	1892	Burma	Burma	
,, ,,	1897	Burma	Burma	
,, *longispathus* ...	1885	Chittagong	Lower Bengal	
,, ,, ...	1891	Burma	Burma	
,, *strictus* ...	1897	Coimbatore	Madras, Deccan	
,, ,, ...	1899	Seoni (C.P.)	Central Provinces	
,, ,, ...	1901	Thana	Gujarat, Bombay Deccan	
Melocanna bambusoides.	1863-66	Chittagong, Calcutta	W. & C. Bengal	Famine 1865-66
Ochlandra Beddomei ...	1876	Sisbara Ghat	Madras, Bombay	
,, *Talboti* ...	1896	Throughout N. Kanara	Bombay and Madras, Deccan	
Oxytenanthera albociliata	1891	Burma	Burma	
Several bamboos ...	1857	Calcutta, Lower Bengal	Calcutta, Lower Bengal	

Periodicity of Flowering.

We come to the most difficult question: How can the periodicity of flowering be explained? It is the same problem which arises in the case of many species of the genus *Strobilanthes*, of the Talipot Palm and even, to a certain extent, of a number of trees in temperate countries.

Various Opinions.

J. B. Jones in a communication to the Agricultural and Horticultural Society of India (*Journal*, vol. xiii, pt. i, *Proc.* lv) says: The fact that this seed-bearing 'is not confined to the more matured plant, both old and young flowering at the same time, would almost lead one to doubt, that it follows the regular course by which nature governs the other orders of vegetation; but rather that, as has been observed, it may be encouraged by particular circumstances connected with elemental changes.'

J. D. Hooker is practically of the same opinion. In the account of his journey to Tonglo from Darjeeling he makes the following remarks about the flowering of the bamboo: 'At about 4,000 ft. the great bamboo ('Pao'' lepcha) [*Dendrocalamus Hamiltonii* Nees & Arn.] abounds; it flowers every

year which is not the case with all others of this genus, most of which flower profusely over large tracts of country once in a great many years, and then die away, their place being supplied by seedlings which grow with immense rapidity. This well-known fact is not due, as some suppose, to the life of this species being of such a duration, but to favourable circumstances in the season.' (*Himalayan Journals* i, 155).

To Camus periodical flowering is a kind of sickness: 'The stems,' he says, 'produce branches with leaves during 10, 20, 30, 50 years, without flowering, then the leaves fade, at least partially, the plant appears to be sick and then numerous buds are formed from which emerge countless flowering spikelets.' (Camus, *Les Bambusées*, (1913) 187).

W. Seifriz in discussing possible factors which may cause periodicity shows that seasonal differences, particularly in moisture, are probably insufficient to explain them, and suggests that the problem may be of the same nature as that of puberty and senility in organisms (*Amer. Journ. Bot.* 7 (1920) 83-94).

Others are of opinion that, when the rhizome of a bamboo clump has attained a certain age, it must necessarily produce flowers and seed in the place of leaves.

Similar is the assumption of some writers that the condition of the rhizome, i.e., the accumulation in it of a sufficient quantity of starch and other substances, is one of the conditions that must be fulfilled before flower-buds can be formed in the place of leaf-buds.

Troup, though admitting the possibility of the life-cycle of the bamboo being influenced to a slight extent by climatic and other causes, is of opinion that it is primarily determined by physiological causes inherent in the plant. This is also the idea underlying a paper by Kawamura on the causes of flowering in bamboos, published at Tokio in 1911.

Hori denies the inner periodicity of the flowering bamboo and says that external conditions alone form the decisive factor. In a paper on the 'Flowering Disease of the Bamboo' (Tokio, 1911) he mentions as causes of flowering dryness of air and soil and especially a strong accumulation of sugar in the plant-body.

From the fact that fruit trees are induced to flower by cutting their roots and thus reducing the absorption of water and from the experience that in regions with distinct dry and wet seasons the flowering season always coincides with the dry season, Loewe concludes that a certain concentration of sugar in the plant is a *condicio sine qua non* of flower-production.

Sachs, when trying to explain our problem, ascribed the phenomenon to certain 'flower-forming' substances, whose chemical nature he was not able to define but which could be stored up together with the reserve-materials.

All these different opinions can be considered under three headings: The Fixed-age Hypothesis, the Climatic Hypothesis and the Physiological Hypothesis.

The Fixed-age Hypothesis.

We need not lose many words over this hypothesis. If nature had given a definite age to every species of bamboo, it is clear that all the clumps of a certain species would flower after the same number of years and die. This is evidently not the case after what we have seen before. So far we have not observed one species of which we can say definitely that its life-cycle is, e.g., 30 or 35 years. It lies in most cases between two values. Besides, we have seen so many exceptions above when dealing with irregular flowering, the flowering of offsets and seedlings, which we cannot reconcile with an innate fixed age of the species.

Kawamura is of opinion that the time of flowering is determined by internal factors and very little dependent on external influences. According to ancient Japanese and Chinese records the periodicity of flowering in bamboos is very regular and definitely fixed. Kawamura mentions *Phyllostachys puberula* which, he says, comes into flower at intervals of 60 years. At the last general flowering of this plant it was observed that at the same time cultivated specimens in Europe were flowering. This extraordinary coincidence is explained by the author in the following way: '*Phyllostachys puberula* is always propagated vegetatively, i.e., from rhizomes, from which it follows that all clumps growing at present all over the world are parts of one or a few cultivated individuals. If the flowering time follows an internal fixed periodicity, it is necessary that all

the specimens scattered over many countries come into flower at exactly the same time as those growing in the native country'.

It cannot be denied that the argumentation is correct, but we cannot say the same of the premises. Kawamura evidently refers to the general flowering of 1900 which took place in Japan and several localities in Europe. But he seems to have overlooked the fact that the same species was seen in flower in Japan in 1889, in Sussex in 1898, in Europe in 1906, in the Temperate House of Kew in 1902, and in the open air at Kew from 1903–1905.

The Climatic Hypothesis.

We have a certain amount of evidence which points to the likelihood that abnormal heat and drought stimulate flowering. Here are a few statements in favour of the climatic hypothesis.

We know from Sleeman's report that in the early part of 1857 many of the bamboos in Calcutta and other parts of Lower Bengal blossomed and seeded abundantly; the season had been unusually dry throughout Eastern Bengal and on to Assam, where the scarcity of grain was much felt.

In 1868 and 1869 Kurz spent two dry seasons in Burma on the look-out for material for his *Forest Flora.* He met an unexpectedly large number of bamboos in flower. He ascribes this fact to the unusual heat and drought of those seasons.

In 1864 there was a general flowering of *Bambusa arundinacea* in N. Kanara and another in 1865 in the Balaghat district (C. P.). *Bambusa tulda* was in flower in 1866 in Lower Bengal. We know that in Bengal and a large portion of the Peninsula the monsoon of 1864 and 1865 was scanty and that great drought and heat prevailed.

Bruce (*Ind. For.* xxx, 269) reports that in the Ruby Mines District *Dendrocalamus strictus* had flowered on the most exposed situations and in the hottest localities, while the clumps growing in sheltered and cooler areas had remained green.

Of *Bambusa arundinacea* Haines says that it flowers more or less gregariously, 'but those in the immediate vicinity of streams will sometimes flower some years after the ones in less favourable localities. It flowered and seeded in Puri and Angul from 1896–99 and again in 1913–15. In the former case the larger better bamboos in the damper localities are said not to have flowered: it was these, however, which flowered in the later period.'

Here should be included the numerous cases of coincidence of general flowering and famines mentioned on a previous page.

It may be interesting to remember repeated observations of a second flowering of trees in Europe, e.g., of the Chestnut, Syringa and others, especially during the hot and dry summer of 1911.

Against the climatic hypothesis we can adduce the following points:—It cannot be proved that periodic flowerings have always taken place during or after years of drought and scarcity. I say on purpose 'after years', because stimulating conditions must exercise their influence on the plant at least one year before flowering can take place.

We know by experience that general flowerings have occurred in localities where drought is unknown.

How can we reconcile the following case with the climatic hypothesis?—*Chusquea abietifolia*, of the Blue Mountains of Jamaica, went through a general flowering in 1918, during which practically all individuals blossomed, seeded and died. The next year the species was represented only by seedlings, except for one small area discovered by Seifriz in an unusually arid situation where the plants were still thriving and flowerless. (*Americ. Journ. Bot.* 7 (1920) 83–94).

If the climatic hypothesis rests on a solid foundation, how are we able to explain that certain bamboos behave, regarding their period of flowering, in almost exactly the same way quite independent of climatic conditions? *Dendrocalamus strictus*, e.g., grows both in the most tropical climate of Burma and the west side of the Peninsula, as well as in the dry region of N. W. India, in the Aravalli Hills, the Salt Range, and the Sub-Himalayan tract, nearly to the Indus.

The strongest evidence against the climatic hypothesis is, in Troup's opinion, the fact that bamboos grown artificially by offsets or from seed may flower simultaneously with clumps of the parent stock, or with others raised

artificially from the same stock, in different localities under different climatic conditions. We have seen above how bamboos behave with regard to the time of flowering when cultivated in or out of India.

In the case of bamboos grown in Europe and Africa which flowered at the same time in different places, it is not only the difference of climate we have to consider but also the various kinds of treatment they have received from different amateurs and horticulturists. If we had only one instance of several clumps of bamboo flowering in the same year in various localities including their native country, it would be quite enough to overthrow the climatic hypothesis.

By this we do not want to imply that drought and heat may not have some influence in stimulating the plant to flower, but that influence should not be considered as anything more than an acceleration by a short time of the ordinary process of flowering. In other words, drought and heat alone will not bring about flowering unless the plant has already reached the end of the physiological life-cycle and is, in any case, on the point of flowering.

The Physiological Hypothesis.

When Troup says that the life-cycle of a bamboo may be determined by physiological causes inherent in the plant, he abstains from defining those causes. Other writers speak of an accumulation of starch in the rhizome, of a strong reserve of sugar in the plant-body, others again of a certain concentration of sugar or of the presence of certain 'flower-forming' substances. The leading idea of all these and similar opinions is this, that there are in the plant a certain substance or substances or configuration of substances which, when they have reached a certain amount, induce the plant to produce flowers and seed.

Chemical Action.

What those substances exactly are must be investigated by experiment. With regard to many plants, we know that strong manuring prevents flowering whilst scanty manuring promotes it. But very few methodical experiments have been made so far. Reduction of salts in *Algae* is decisive for fructification and this has also been claimed for phanerogamic plants. Loew (1905) has shown for garden plants that an increasing amount of Nitrogen, given in the shape of Ammonium Nitrate, has retarded the formation of flowers. Montemartini (1910) experimented with *Torenia Fournieri* and *Solanum nigrum*. He put the plants every 4th or 5th day into a fresh solution containing all the necessary elements. They developed well but did not flower. As soon as the plants were transferred to a solution without N, they started flowering at once. It was also found that in a solution without phosphorus flowering was prevented.

It is, however, not enough to observe the outwardly visible effects of certain salts. We want to know what internal changes are going on at the same time. For this purpose the chemical examination of the plant in its vegetative and flowering stage would be necessary, and of the vegetative stage not only once in the life-time of the plant but at regular intervals from the beginning up to the time of flowering. Very little work has been done in this direction. It has been observed that in cereals the nutritive salts constantly increase from germination up to a maximum shortly before flowering begins, and that after that a distinct diminution can be noticed. This, apparently, can only be explained by the excretion of salts, especially Kalium and Nitrogen. At the same time an accumulation of C-assimilates in the shape of starch takes place in the plant. From Berthelot's investigations it appears that the maximum of Phosphorus-content is reached at the time when the plant begins to flower. Chemical analysis of the rosettes of *Sempervivum* in its vegetative stage and at the beginning of flowering has shown that in the latter case they contain more reducing sugar than in the former, whilst the ash of the vegetative rosettes contains absolutely and relatively more N-compounds. If we consider that flowering depends on a certain concentration of C-assimilates and nutritive salts, it will be easy to understand the fact that it is not always necessary to strongly limit the absorption of such salts, provided that a surplus of C-assimilates can be obtained by active assimilation.

A plant growing in soil containing a high percentage of nutritive salts can, on the one hand, absorb only a limited quantity of those salts and, on the other, under otherwise favourable conditions, obtain the required C-assimilates,

From this point of view we can understand the results of many methods in fruit-culture by which we try to promote flowering and fruiting of so-called sterile trees. Some of those methods intend a limitation in the absorption of nutritive salts, e.g. repeated transplantation by which the roots are damaged, cutting of the roots, and dense planting of the trees. Other methods, again, try to prevent the C-assimilates from descending into the roots which is effected by slashing or ringing of the bark or by fixing a wire or a narrow strip of tin round the stem and main branches.

The following facts might be adduced in favour of the physiological hypothesis :—There are entomogamous plants which flower at greater intervals and then simultaneously. Haglund has observed that, e.g. *Phyllodoce coerulea*, *Azalea procumbens*, *Andromeda hyphoides*, *Rhododendron lapponicum*, and *Sedum palustre* come into flower in the high North at intervals of several years. As the same plants flower annually in Central Europe (*Sedum palustre*, *Azalea procumbens*) we feel inclined to say that it is chiefly the accumulation of a certain amount of reserve-materials which causes more frequent flowering. The formation of reserve-materials is naturally slower in the North.

Brandis rightly draws our attention to some forest trees in Europe, the Beech, the Oak, the Spruce and the Silver Fir which do not flower and seed regularly every year, but at intervals which vary in each species with soil, elevation, climate and other conditions. He refers to the interesting researches made by Hartig on the influence of the accumulation of starch in the medullary rays and wood parenchyma on the seed years of the Beech trees.

That stores of starch and other reserve materials were being deposited in the wood of Beech trees was a well-known fact, but it was always supposed that those stores were consumed by the development of leaves in spring. Hartig, however, has shown that starch gradually accumulates in the wood until a moment arises, when it is entirely utilized for the production of flowers and seeds.

Water.

Numerous practical experiences prove that a high degree of moisture opposes the development of flowers, whilst vegetative growth is advanced. This happens when the water-content of the soil as well as of the air is very high. First of all it is relative dryness of the air which promotes flower-formation, as dryness of the air increases transpiration. From Gain's experiments it is apparent that for flowering there is an optimum of transpiration, provided the soil is relatively damp and the air relatively dry. By comparative experiments he deduced the following series of favourable and unfavourable influences on the process of flowering :—Dry air very favourable, damp soil favourable, dry soil unfavourable, damp air very unfavourable. As light is an essential condition for the increase of transpiration, it is evident that it plays an important part in exciting a plant to flower.

Temperature.

As a general vital condition temperature must influence flower-formation because all the other functions connected with that process, viz., assimilation, transpiration, absorption of water and salts, depend on temperature. Regarding the nutritive salts Montemartini has proved that the absorption of phosphoric acid is increased by raising the temperature up to an optimum, which corresponds with the optimum of temperature for the formation of flowers. More striking are the effects of a temperature which approaches the lower or upper limit or also of a middle temperature (ca. 20° C.) as soon as it sets in at certain stages in the development of some plants. The biennial beetroot can, under certain conditions, flower in the first year already. This depends partly on racial characters, but certainly also on various external conditions. Among these it is especially low temperature near 0° C. in spring, coupled with early sowing. It is conceivable that retardation of growth, perhaps also absorption of salts by night, and C. assimilation by day bring about the internal conditions for flower-formation.

Influence of Age.

We know that there is a minimum of concentration of inorganic salts required for the well-being of the plant which lies higher for reproduction than for growth. With regard to the single elements, N, P, etc., this minimum

varies and depends, in addition, on the nature of the plant. As soon as these minima are reached and the necessary surplus of carbohydrates obtained, one should expect that the age of the plant, i.e., the time of previous growth, is of no decisive value and that young plants as well as old ones can produce flowers according to circumstances. Deels, indeed, has shown for a number of plants that they come into flower at a relatively early age without long previous growth. Even a tree like the Oak, which usually flowers after 60 years, can produce flowers in its first, second or third year. Other facts, too, prove that under certain conditions the influence of age can be neglected. A rosette of *Sempervivum Funkii* usually flowers in its third year and then produces only one inflorescence. But, with ample food-supply in the foregoing year, the rosette ready to flower produces daughter-rosettes in spring, which after little growth start flowering at once. The fitness to flower of the mother-rosette has, therefore, been directly transferred to the daughter-rosettes which come into flower in spite of their young age and the small absolute quantity of nutritive substances in the small rosettes. The same event has been observed in *Agave* whose rosettes flower only after many years, whilst daughter-rosettes flowered immediately after removal from the mother which was ready to flower. Leaves of Begonias which were on the point of flowering form flowers on the adventive shoots much sooner than leaves of non-flowering plants. Similar behaviour observed in bamboos has been mentioned above.

Intimately connected with the question regarding influence of age is the other question regarding the length of flowering. There is a great variety which is based on specific properties of the plants. There are plants which flower any time of the year, e. g., the Daisy (*Bellis perennis*), there are others of which the same individual can go on flowering for years (*Parietaria erecta*), a not uncommon occurrence in the tropics. On the other hand, we know plants with a very definite time of flowering, either spring, summer or autumn. Some plants flower only once in their lifetime, e. g., the Talipot Palm (*Corypha umbraculifera* Linn.), the Sago Palm (*Metroxylon Sagus* Rottb.). And finally we have the gregarious flowering over wide areas of many species of *Strobilanthes* and bamboos.

Other Factors.

There are several other factors which are apt to influence flowering but which so far have not received the slightest attention at least in so far as they are related to reproductive processes, e. g., the absorption of organic food from the soil, the bacteria living in the soil, the substances secreted by the plants, the influence of Oxygen acting either directly or indirectly on the organism, the changes effected by the presence of various amounts of Co_2 in the air, etc.

How to Explain Gregariousness of Flowering.

All we have said and suggested up to now may lead some day to a better understanding of periodic flowering, but it will not clear up the still more difficult problem of gregarious flowering. Troup is the only botanist who has tackled the question. His theory is so ingenious that I cannot help reproducing the whole passage: 'If the constancy of the life-cycle is accepted as a fact the phenomenon admits of a possible explanation. In the case of species like *Dendrocalamus strictus*, *Cephalostachyum pergracile* and *Bambusa tulda*, which frequently flower sporadically, the flowering may be observed in single clumps, or in patches of a few clumps together, which apparently sprung from a solitary flowering clump of the previous generation, or in small groups of less than an acre, apparently the result of the spread of the seed from one or a few flowering clumps of the previous generation, or in larger groups. And so the progress can be traced from small to large groups of varying size and thence to general flowering over restricted areas and finally to gregarious flowering over considerable tracts of country. This would lead to the conclusion that gregarious flowering is the result of the gradual spread of the species, through successive and more or less constant life-cyles, over a wide area from one or a limited number of original flowering individuals. If this be so, then in the case of those species like *Bambusa polymorpha*, which flower at long intervals with a marked tendency of gregariousness over extensive tracts, the process of taking possession of the ground must have occupied a considerable period of time, and the life-cycles of the various individuals of the crop must have been remarkably constant.'

It almost comes as a shock when in the next line Troup continues: 'This theory, however, is discounted by the fact that in certain cases of gregarious flowering young plants only a few years old have been found to flower with the mature clumps.' He then gives an instance of a general flowering of *Dendrecalamus strictus* in the Chanda district (C. P.) in which Smythies (*Ind. For.* xxvii (1901) 126) observed clumps of all ages in flower, not only mature clumps but also young plants of six or seven years' growth or even less. But here as in another case taken from the *Ind. For.* (xxxiii (1907) 323) the important question arises whether those younger plants grew from seed or from the rhizome of an old plant. It is not evident from the two reports and till we have further proof there is no need for discounting Troup's theory.

CONCLUSION.

We have discussed a few of the problems connected with the flowering of bamboos and we must confess that we know very little about them.

There are innumerable other questions regarding the physiology of sexual reproduction, which we have not even mentioned for the simple reason that we have no facts from which we could derive satisfactory conclusions.

A flower is a most complex structure, even for the student of morphology and anatomy. But if we begin to look at it from the physico-causal point of view, endless vistas open out before us and wherever we turn for an answer, we only find a sign of interrogation staring at us. The pathological changes produced artificially in some plants by Klebs seem to indicate that the external conditions for the formation of the single organs as calyx, corolla, stamens and carpels are not the same and that each of these structures depends on a special combination of external factors. A clear insight into these conditions has not been gained as yet, and the physiological questions regarding pollination, fertilization and development of the embryo have scarcely been touched upon.

It is scarely necessary to repeat that flower-formation depends essentially on influences coming from the outer-world. These external factors are the general conditions to which every vital process is subject. For flower-formation are characteristic the special combination and intensity of these factors as light, nutritive salts, Carbon dioxide, Oxygen, absorption of water, transpiration, temperature and perhaps others, of which we are not conscious. It does not seem possible to analyse the constant and intricate co-operation of all these factors and to find out what exact effect is produced by each of them. Some facts, however, appear to justify the assumption that flower-formation is brought about in the first place by an increase in C-assimilation and by an absolute or relative decrease of certain nutritive salts, especially of those containing Nitrogen. We are thus allowed to assume that a certain concentration of those substances in the meristematic cells of the plant forms the necessary internal condition of reproduction. Every attempt to trace these relations more accurately and to define them more clearly, seems to be hopeless at the present moment, as we are too little acquainted with the complicated chemism of the cells. Chemical analysis with the present-day methods can only give the rough distribution of matter, but is quite incapable to present a true image of the more delicate processes that lead up to the formation of flower and seed.

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NOTES ON THE FAUNA OF BRITISH INDIA: BIRDS.

VOLS. IV, V AND VI. (*New edition*).

BY

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At the request of several friends who are interested in the Indian avifauna and at the urgent demand of the Editors of the Journal I have completed some further notes on the Fauna of British India, second edition. These notes which cover Vols. IV, V and VI are continuation of my former notes (vide *Bombay Nat. Hist. Soc. Journal*, August 1926 and October 1927) and comprise points which occur to me in reading through these volumes. They in no way are an exhaustive commentary; such would take up far more time than is at my disposal; moreover, a good many of the species dealt with, I have no special knowledge of, and therefore pass them over. Mere printers' errors (and there are many) also I pass over unless they are of moment. For convenience of reference, I quote the page of the *Fauna* referred to in each case and use the same nomenclature, though I do not necessarily always agree with it.

VOL. IV.

p. 7. *Picus squamatus*.—I gather from the distribution here given that both *squamatus* and *flavirostris* occur in Beluchistan. The only specimens I have seen from Beluchistan are *flavirostris*. At all events we must call them *flavirostris* at present. This race was described from the confines of N. W. Afghanistan (Murghab, R.) and *gorii* from the Helmund is said to be the same race. There are so few specimens available that it is not possible to say whether the Beluchi bird is separable or not. It certainly occurs and breeds in the Ziarat juniper forest where I have seen it and examined old nest holes. Does *squamatus* occur in Sikkim? Stevens does not record it thence.

p. 29. *Hypopicus hyperythrus*.—Mr. Whistler and I have dealt so thoroughly (*Ibis*, 1924, pp. 468-473) with this bird and Vigor's types that anything further would seem superfluous. Our researches all tended to show, contrary to Mr. Baker's assertion that in this collection described by Vigors 'there were a few Eastern Himalayan birds among them', that all these birds except *Myophonius horsfieldi* came from the Western Himalayas or foot-hills.

p. 35. *Dryobates scindeanus*.—Appears to be antedated by *Dryobates assimilis*, Blyth (*J.A.S.B.*, XVIII, 2, p. 803, 1849). Type locality Rawalpindi. (ex. Natterer MS.?).

p. 40. *Dryobates macei*.—This species certainly does extend as far west as Murree (Specimens, Whistler coll.) but the western race

is easily separable by the longer bill and wing from the Bengal race. ♂♂. W. 114-118. B. 26-30. The western form is *Dryobates macei westermani* Blyth. (*Ibis*, 1870, p. 163.) Type in Amsterdam Museum.

p. 45. *Leiopicus.*—This genus can hardly be maintained. The difference between the tips of the secondaries and primaries is said to be less than the culmen length in *Leiopicus.* This is not true of every specimen and, if the character is taken, I find that while *major, minor, pubescens, auriceps, leuconotus* and *medius* would fall into the *Dryobates* group, *villosus* becomes a *Leiopicus,* and *scindeanus* and *syriacus* with *macei* doubtful for either group, some specimens falling into the *Dryobates* group and some into the *Leiopicus.*

p. 47. *Leiopicus mahrattensis blanfordi.*—This northern bird I consider to be a good race. Not only is the white more extensive as here noted, but the birds on the whole are larger.

mahrattensis 26 ♂♂. W. 93-101. once 107. B. 23·5-26. Most 24-25.
10 ♀♀. W. 91-101. once 103. B. 21-24. Most 22-23.

Birds from N. India.—
58 ♂♂. W. 100-111. (four under 100). B. 24-27 (odd ones N. W. India, up to 30).
51 ♀♀. W. 100-108 (five under 100). B. 23-26 (odd ones from the east side, 21 and 22).

Burma.—7 ♂♂. W. 100-106. B. 22·5-26.
7 ♀♀. W. 102-104 5. B. 21-23·5.

Burmese birds are quite like N. Indian ones, but on this small series seem to have a trifle shorter bill. However, as there is much overlapping and the series small, I should not recognize two races here. The name of the northern race is not *blanfordi* but *aurocristatus.* Tickell (*J.A.S.B.*, ii, 579, 1833.) Type locality Bhorabhum, Bengal.

p. 48. *Yungipicus.*—I cannot see that this genus can possibly be maintained. The difference between the tips of the primaries and secondaries is said to be greater than the length of the tarsus in *Yungipicus.* That is quite true, but it is also equally true in *Dryobates pubescens,* the type of the genus *Dryobates* and also in many other species of *Dryobates.*

p. 51. *Yungipicus hardwickii mitchelii.*—This bird extends much further north-west than Mussoorie. Mr. Whistler obtained it in the Kangra district and at Rawalpindi. There is a small amount of information on the nidification of this race in Hume's *Nests and Eggs,* ii, 306.

p. 70. *Brachypternus b. dilutus.*—This species of course grades into the typical form, the distribution being continuous. The birds I identified as belonging to the Sind race were from S. W. Punjab.

p. 72. *Dinopicus.*—*Picus* is masculine and presumably *Dinopicus* also; *intermedius* and not *intermedia* therefore.

p. 78. *Key.*—In first line for breast, *back* is meant.

p. 93. *Picumnus innominatus innominatus.*—This Piculet occurs much further west—to Dharmsala.

p. 100. It is stated that, unlike Woodpeckers, Wrynecks can run backwards and downwards with facility. I cannot speak for certainly about other woodpeckers, but I have frequently seen *Picus viridis* run backwards and downwards on a tree trunk.

p. 100. *Jynx torquilla japonica.*—I agree that this is the form breeding in Kashmir, but it does not breed or occur in Beluchistan. The race there is the typical one and only as a passage migrant. Does it breed all along the Himalayas? I doubt it. A winter visitor to Sikkim (Stevens). The bird occurring in the Punjab and Sind in winter is the typical race. Mr. Whistler and I have failed to find a single winter specimen of *japonica* in this area.

p. 113. *Thereiceryx lineatus intermedius.*—An unrecognizable race. 15 Burma W. 120-135, 15 Nepal, Bhutan and Buxa Duars W. 119-139. It seems useless to try and recognize two races on average difference of 7 mm. in wing length. Only extremes could be assigned to either race leaving about 80 per cent unnamable.

p. 116. Key to *Cyanops asiatica.*—'Band across vertex blue . . . *davisoni.*' In the description of this race the band is said to be black.

p. 117. *Cyanops asiatica asiatica.*—This Barbet is said to be 'rare anywhere east of Nepal'; this is certainly not so and it is common in some districts to the west of Nepal.

p. 126. *Xantholæma.*—The key here is obviously wrong. It divides *Xantholæma hemacephala* with culmen 16 mm. or over from *indica* with culmen *15 mm. or under*, but in the measurements given under the description of *indica*, the culmen length is given as 17-18 mm.

p. 136. *Cuculus canorus canorus.*—The distribution given will need amending. The breeding range 'practically all Europe within the Arctic Circle' is really only a very small part of this bird's range in summer; it breeds throughout most of Europe outside the Arctic Circle as well. I have already twice pointed out (*Ibis*, 1916, p. 38) that the breeding bird over a large area of the Punjab belongs to the typical race. I do not think this bird winters in India at all and certainly not in the North-west. As Mr. Whistler and I have pointed out again and again, it is a passage migrant in autumn and there are *no winter records* of it in Sind or the Punjab.

pp. 141-3. *Cuculus optatus and poliocephalus.*—It is not clear what is meant by 'young birds', 'second stage', 'third stage'. Are these different sequences of plumage, or individual variations, or dimorphisms of one plumage? The same remarks apply to the descriptions of some of the other Cuckoos, e.g., *Caccomantis merulinus, Hierococcyx, fugax, Chalcites xanthorhynchus, etc.*, where 'young bird', 'nestling' (surely the same plumage !) and 'older plumage' are distinguished.

p. 157. *Penthoceryx sonneratti.*—Latham described this bird from India in 1790. At that time N. Cachar was not within Indian territory and it is most unlikely that Latham's bird came from there. I suggest Bengal as being more probable as the type locality. The differences given between *Penthoceryx* and *Caccomantis* do not seem to be generic ones.

p. 167. *Clamator jacobinus.*—The impression here given is that

this Cuckoo is a common bird all over India at all times of the year. This certainly is not so; over a huge part of India it is a 'rains visitor' and as such, a marked migrant. Where does it go to in the non-breeding season? S. India? Africa? (see also *B.N.H.S.J.*, xxxiii, p. 136, where Mr. Whistler has dealt in detail with this question).

p. 185. *Toccacua leschenaulti leschenaulti.*—The date of *leschenaulti* in the text is given as 1830, and in the heading as 1831.

I see no difficulty about the question as to where Blyth's *infuscata* came from. When Blyth wrote his *Catalogue* he only had one specimen of *infuscata* and it came from the 'Tarai region near Darjheeling' which therefore must be the type locality. Working with the same material as I did (*Ibis*, 1923, p. 41), Mr. Baker has come to rather different conclusions. I could not separate the Hill Sirkeer (*infuscata apud* Baker) from the Punjab Sirkeer (*sirkee*), and *affinis* I felt very doubtful about as there are no specimens from the type locality and only two from Bengal at all. I, therefore, put the Southern Bengal birds with *leschenaulti* which they appeared quite to resemble. I used *infuscata* for the N. E. sub-Himalayan bird.

pp. 205-6. *Psittacula cyanocephala.*—The distribution of *cyanocephala* and *bengalensis* is very curious. The former is said to be the race in Western Bengal, Sikkim and Bhutan Duars, and the latter to be the race in Bengal, Nepal and Sikkim. Is this correct? It seems that there is considerable overlapping.

p. 210. *Psittacus alexandri.*—The reference here must be wrong; 1754 belongs to the pre-Linnean era. The reference should be *Linn. Syst. Nat.*, Ed. X, 1758.

p. 215. *Psittacus incertus* (Shaw. Nat. Misc.).—It is not stated where the typical form comes from but the type locality can be India only 'in error'.

p. 129. *Psittinus beryllinus* (Forster, 1781).—Here, as in a good many cases throughout this work, the original reference is given with a generic name the original describer could never have used. Besides being incorrect, it is confusing.

p. 222. *Coracias garrula.*—The typical race is said to be lighter in colour than the Indian bird. It is slightly *darker* in summer dress, but in the juvenile dress and winter plumage *very markedly so*. Single birds from Kashmir are a trifle larger than any from elsewhere within the range of *semenowi*, but on a series no appreciable difference can be seen.

Kashmir. W. 195-212. T. 120-137. B. 41·5-47.

Iraq, Persia, Punjab and Sind. W. 185-208. T. 118-137. B. 40-45.

Semenowi was described from Transcaspia and birds from Turkestan do not appear to me to be smaller than Kashmir birds though odd ones from the latter locality are large.

p. 232. *Melittophagus.*—It is said that this genus is only distinguished by the central tail feathers not projecting beyond the rest of the tail and are of similar shape to the lateral. It seems a very poor generic distinction. The central tail feathers in *M. erythrocephalus* are *not* the same shape as the laterals; and in the juveniles of *Merops* the central tail feathers are of the same length as the laterals. The *genus* seems unnecessary.

p. 233. *Merops apiaster.*—'Young birds' and 'Nestling' are the same plumage and the majority in this plumage correspond best with the description given under the former heading. The distribution is not correct, as this bird does not breed in Garhwal, Sind, Rajputana or the Punjab. It is also implied that in winter it occurs as far south as Pandharpur. This Bee-eater does not occur anywhere in India in *winter*; it is, as I have already pointed out, a passage migrant in N. W. India.

p. 237. *Merops orientalis biludschicus.*—Does this bird breed at Quetta? I could find no record of its doing so, nor did I see it there.

p. 239. *Merops s. persicus.*—I do not think there is any mystery about the movements of the Persian Bee-eater. It is known to winter in tropical Africa and is known to breed in Egypt, Palestine, Iraq, Persia, Transcaspia, Afghanistan, Beluchistan and parts of N. W. India. Between these two areas it is a common passage migrant in many places such as Egypt, the Red Sea, Arabia, Persian Gulf, Iraq, Beluchistan, etc.

p. 246. *Ceryle rudis.*—I should think that the typical race is most unlikely to occur in Sind where *leucomelanura* is common. The typical race is only known to occur as far east as the Shiraz district in S. Persia. East of this appears to be a gap in the distribution of this species till in Las Belas *leucomelanura* occurs. The typical form is hardly likely to wander from Persia to Sind.

The type locality of *Ceryle rudis* is not Persia but Egypt; it was described by Linnaeus ex Hasselquist.

p. 253. *Alcedo atthis pallasii.*—I do not think it is certain that *pallasii* breeds in Sind. Both this and *bengalensis* occur; but which breeds I could not ascertain as there appeared to be no breeding birds in any collection. Mr. Whistler is in the same difficulty over the Punjab. But in Kashmir where this Kingfisher is common, the breeding bird *is pallasii.*

p. 254. In the Key to *Alcedo meninting* the statement that the anterior crown is tinged with greenish, I have found misleading. To my eyes (and those of others) it is cœrulean blue and this should be amended in the description of *coltarti.*

p. 258. *Alcedo hercules.*—No type locality is given. As the name is a re-naming of *grandis* which came from Darjheeling, this is the type locality. But the correct name appears to be *megalia* Blyth.

p. 268. *Halcyon smyrnensis* Linn.—Linnæus described this bird from Albin's work and the latter described a bird from Smyrna which is then the type locality.

pp. 308-313. *Upupa epops* races.—The measurements of the wings of *saturata* and of *orientalis* do not quite tally with my measurements. No example of *saturata* from its breeding area measures as little as 123, I made the smallest 140. Nor could I find any Indian breeding birds of *orientalis* so large as 160; maximum about 140.

p. 323. *Micropidae.*—The keys to the Swifts will need some revision to make them workable. In the key to the sub-families two groups are distinguished, those with feathered tarsi and those with

naked tarsi or nearly so. In the latter group falls the sub-family *Chæturninae*. Turning to page 339 one of the characters of the group is the naked tarsus. This sub-family contains the genus *Collocalia* and turning to page 346 a key to this genus is given and the characters given to two of the species is 'tarsi feathered' !

p. 324. *Micropus melba*.—These Swifts want revising when material is available. I am pretty sure that the North Indian bird is not the same as the South European one. The North African-Palestine bird is I think separable as *tuneti*. Fresh moulted North Indian birds are paler even than spring birds of the typical race.

p. 331. *Micropus pacificus leuconyx*.—This race only differs in size; the colour of the legs and feet are as in the typical race (i.e. purplish-brown or purplish-black) not flesh-coloured.

p. 338. *Tachornis batasiensis palmarum*.—The distribution given is far too wide. Over a huge area of N. W. India it does not occur at all, as for example, in Sind, Punjab and N. W. Province.

p. 350. *Hirundo francica* Gm.—The date should be 1788, not 1799.

p. 354. *Hirundo coronata* Tickell.—The date should be 1833 not 1883.

p. 360. *Caprimulgus europæus unwini*.—This Nightjar does not occur in N. W. India in winter at all. There is no record of it at this season in Sind or the Punjab. It is, however, a common passage migrant and winters in Africa. I made this quite clear in the *Ibis*, 1922, p. 531, and 1923, p. 37.

p. 365. *Caprimulgus nipalensis* Hartert.—This name cannot be used. Dr. Hartert took this name from *Hodgson's* M.S., but as a *nomen nudum* it had already been made a synonym of *albonotatus* by Blyth in his *Catalogue*.

p. 369. *Caprimulgus mahrattensis*.—Also breeds in the Punjab Salt Range.

p. 405. *Strix butleri*.—Of this mysterious Owl two further specimens have been obtained in the Wadi Feiran in Palestine and probably elsewhere there (vide *B.N.H.S.J.*, xxxi, p. 64).

pp. 408-9. *Ketupa zeylonensis*.—Races of this Fish Owl are no doubt very difficult to elucidate and Mr. Baker and I, on examining the same material, have come to quite different conclusions. I felt very doubtful about recognizing any races at all since there are only five specimens from Ceylon in the British Museum. However, I restricted *zeylonensis* to Ceylon and recognized *leschenault* from the rest of India. Mr. Baker can on the same series recognize four races! As regards the two Sind and N. W. F. Province birds, I have already pointed out that these differ very markedly from any others and do *not* correspond with topotypes of *semenowi* from Arabistan and in fact these latter could be matched with birds from India. When two such entirely different results are attained with the same material, it suggests that the races are very poor ones or the material is very insufficient.

p. 411. *Ketupa flavipes*.—This is listed by Ward as uncommon in Kashmir, but no one else seems to have met with it at all.

p. 419. *Huhua orientalis*.—This is *Strix orientalis* of Horsfield 1821 but not the *Strix orientalis* of Shaw 1809 and therefore unfortu-

nately *orientalis* cannot be used for this bird. The correct name for the Malay Eagle Owl then is *Huhua sumatrana* (Raffles) and the Javan race *Huhua sumatrana strepitans* (Temm.). *Strix orientalis* of Shaw is a re-naming of *Strix sinensis* of Lath. (*Ind. Orn. Sup.*, xvi, 1801) preoccupied by the same name in the *Ind. Orn.*, i, p. 53, 1790. Hence the bird on page 403 called *Strix seloputo* should be *Strix orientalis* Shaw or, if the Javan bird is a distinct race, *Strix orientalis seloputo*.

p. 432. *Otus brucei*.—This Owl has also occurred at Phillaur in the Punjab (Whistler coll.). This bird certainly breeds in the Chaman-Quetta district as I have seen nestlings from both places.

p. 434. *Otus scops rufipennis*.—This is of course a race of *sunia* not of *scops*.

Otus scops leggei.—This too is a race of *sunia* (vide *Ibis*, 1923, p. 242).

p. 437. *Otus sunia modestus*.—I included the Burmese bird with *japonica* from Japan (*Ibis*, 1923, p. 243) because I could see no sufficient or constant difference between the two. The series from Japan in the British Museum is not very large and the birds thence are highly variable in colour and pattern and one could pick out Japanese birds to match Burmese ones. If one compared Burmese birds with the series in the British Museum from the Amur, the two are easily separable; however, *japonicus* was not described from *Amur* but from Japan.

p. 433. *Otus scops pulchellus*.—This bird may be a winter visitor to Sind; there are too few records of it to indicate for certain, but it certainly is a *summer* visitor to North Beluchistan and breeds in the juniper forest at Ziarat and doubtless elsewhere.

p. 437. *Otus sunia malayanus*.—The date of this description should be 1845, not 1842.

p. 438. In the Key to species the first primary in *brama* is said to be longer than the seventh. This is not constant. Sometimes it is longer, sometimes equal, sometimes shorter.

In the Key to sub-species it is stated 'wing under 145 mm . . . *pulchra*' but in the measurements of *pulchra* on page 441 the wing length is given as 143-158.

p. 441. *Athene noctua*. Scop.—The type locality is Carniola, not Sweden.

p. 445. *Glaucidium cuculoides rufescens*.—Type locality omitted; it should be Manipur.

p. 449. *Glaucidium radiatum malabaricum* (Sharpe, 1883).—This was named by Blyth (*J.A.S.B.*, xv, 280, 1846).

p. 456. *Ninox scutulata isolata*.—The type is said to come from Camoorta. It may be a small point, but we may as well be accurate. Mr. Baker himself described this bird from Car Nicobar at the reference given.

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p. 13. *Gyps f. fulvescens*.—This is almost certainly the breeding bird round Quetta and probably in the Kirthar range too.

p. 15. *Gyps tenuirostris* and *G. tenuiceps*.—Certainly neither of these names can be used. Blyth made them both synonyms of *indicus* in his *Catalogue* some years before Gray did so.

p. 31. *Key to Genera*.—This key fails at C 6, as in *Astur* the bill is far longer than three quarters the length of the hind toe without claw.

p. 32. *Falco calidus*. *Lath*.—The date is 1790, not 1709.

pp. 43 and 44. *Falco subbuteo centralasiæ* and *jarkutensis*.—These two races of Hobby seem to be exceedingly poor ones; in Europe one may find paler or darker birds than the average and the same appears to be the case in Asiatic birds. The difference in measurements too is almost negligible and only a very small percentage of either could be differentiated on the two characters together. The distribution given of the three races suggest too that they are not sufficiently defined to be recognizable. Thus the typical form is said to extend from West Europe right across Asia to Japan, *centralasiæ* in Central Asia; *jarkutensis* also in Central Asia.

p. 47. *Foot note*.—Also the name *Falco indicus* cannot be used as it is preoccupied by *Falco indicus* Gm.

p. 59. *Erythropus amurensis*.—The distribution given as regards India is 'in winter in N. E. India.' Here seems a point to which Indian ornithologists might give attention. What exactly *is* the status of this bird? The older records do not suggest at all that these birds winter in N. E. India. It is true there are records of odd birds in January and February in Pegu and Cachar. At Dibrughar, Hume expressly says, the birds do not stop; Inglis in N. E. Cachar says all disappear by mid-December and were not seen again till October; in Lower Bengal it is said to occur only in the rains. There are odd, mostly undated, records from Nepal, Darjheeling, Kumaon, Carnatic, Nilgiris and Ceylon. There is a record that thousands were seen passing over Belgaum on November 24. Apart from stragglers, does it winter in India at all? If it merely passes through India to reach winter quarters in East Africa, what route does it take? These are points which require further research.

p. 60. *Cerchneis*.—Surely the genera *Cerchneis* and *Erythropus* cannot be maintained on the characters of the feet. Those in the former *genus* are said to be smaller and weaker than in *Erythropus*. This may be true if *naumanni* is compared with *vespertinus* but assuredly not true if *tinnunculus* is taken for comparison.

p. 61. *Cerchneis tinnunculus*.—The adult female is normally tinged with grey on the rump and tail and the juvenile male acquires the blue grey tail at the fifteen months' moult.

Breeding birds in Mr. Whistler's collection from N. W. Himalayas from 2,000 feet up and from Ladak do not differ from *Falco tinnunculus tinnunculus*. In this series one can see rather paler ones and rather darker ones, some are small (♂. W. 234) and in the same area others are large (♂. W. 250). This same variation is seen both in colour and in size in European birds, and all of these birds of Mr. Whistler's can be matched with British examples.

p. 64. *Cerchneis tinnunculus japonicus*.—This name cannot be used. It is the *Falco japonicus* of Temminck and Schlegel but not

the *Falco japonicus* of Gmelin (Syst., I, p. 257, 1798). In the *Bulletin, B.O.C.*, October 1929, I re-named it *japonensis*.

p. 67. *Aquila fulvescens* was described by Gray, not Brooks. This bird, according to Jerdon, Murray, Hume and Sharpe, is what we now call *vindhiana*. Brooks for a time believed it to be a distinct species and Blanford followed him.

p. 69. *Aquila heliaca heliaca.*—Is it quite certain that this bird breeds in the Beluchi-Sind hills, i.e., the Khirthar? It is said to build in trees; if so, I can imagine no place less likely to attract it.

p. 75. *Aquila clanga clanga.*—Hume did not record this Eagle nesting in Sind on his own observation. He says that he was informed that it breeds commonly there. If Rattray found it nesting at Shikarpore in Sind, I suppose there is no doubt about it.

Aquila hastata.—Besides the distinctions given, this appears to be a smaller bird than *pomarina*.

p. 117. *Ichthyophaga h. plumbeus.*—The distribution given implies that this bird is common in Kashmir. It only occurs in one place in the Jhelum valley and in Kashmir it has been much confused with *H. leucoryphus*.

p. 121. *Milvus.*—It is said that no generic difference can be seen between *Milvus migrans* and *lineatus*. I do not think any generic difference has been suggested. Perhaps specific difference is meant.

Milvus migrans.—The ranges of this Kite and *govinda* meet in the Quetta district; *migrans* is a summer visitor from Africa to the wooded hills, *govinda* has extended up the Quetta valley from India.

p. 136. What a troublesome group the Indian Buzzards are! and I fear I can contribute nothing to their elucidation. I do not, however, feel that even now the names, distribution and status are correct. No two people seem to agree about them and no doubt more and better collected material is required. Witness the treatment by three experts :—

Stuart Baker.		Hartert.		Blanford.
Buteo rufinus rufinus.	=	*B. ferox ferox.*	=	*B. ferox.*
Buteo hemilasius.	=	*B. ferox hemilasius.*		*Buteo leucocephallus. Archibuteo hemiptilopus.*
Buteo burmanicus.	=	*B. buteo japonicus.*	=	*Synonym of Buteo, desertorum.*

One almost despairs of reaching the correct name of the Long-legged Buzzard! All three of these Buzzards are said to breed in Kashmir. I wonder if this is so; it is a country in which Buzzards appear to be remarkably scarce and personally I should not feel inclined to accept any identification of breeding unless the breeding bird was obtained.

p. 150. *Astur badius cenchroides.*—Here, as in some other cases, Mr. Baker entirely misquotes what I said. I certainly never said *cenchroides* bred in Sind. I was most careful (*Ibis*, 1923, p. 227), to say that I had seen no breeding birds of the Shikra but that both

cenchroides and *dussumieri* occur in winter and one, probably the former, must be a winter visitor.

p. 158. *Accipiter nisus melanoschistus.*—This Sparrow hawk also breeds in the juniper forests of Beluchistan, which fact I have already recorded and I have examined breeding specimens thence. It is quite common there.

p. 167. *Foot note.*—It is true Hume (not Blyth) records in his Sind diary (*S.F.I.*, p. 103) that he shot (not only saw) an example of *Pernis cristatus* in Sind. Either *Pernis* was a *lapsus calami* or Hume found that his first identification was not correct as he omitted the species in his Sind list.

p. 117. It is not quite true to say that Pigeons are born naked. They have a wiry sort of down more or less all over the body.

p. 179. The Key (2) to the sub-families does not entirely work; there are several pigeons, notably in the genus *Macropygia* in which the plumage is glossed to some extent but whose wings are under 200 mm.

p. 181. *Crocopus ph. phœnicopterus.*—The type locality is given as 'in insula Eimeo'. The locality given by Latham was 'India'. Eimeo is one of the Society Islands and is the type locality of *erythroptera,* a pigeon described lower down on the same page of Latham's *Ornith. Index.*

p. 184. *Crocopus chlorogaster.*—I see no reason to reject Blyth's original spelling *chlorigaster.* This mistake gets copied over and over again.

p. 186. *Dendrophasa pompadora pompadora.*—The distribution has been omitted.

p. 193. *Dendrophasa prætermissa.*—The distribution is omitted.

p. 195. *Treron.*—This does not seem quite clear. It is said that two races *T. c. curvirostra* and *T. c. nepalensis extend through the greater part of our area; nepalensis* is dealt with *curvirostra* is not alluded to again. Does it occur or not?

p. 201. *Sphenocercus sp. sphenurus.*—Though Col. Ward recorded this pigeon as abundant in Kashmir, others do not appear to have met with it.

p. 211. *Carpophaga pusilla* Blyth.—The date of this reference should be 1849.

p. 211. *Columba bicolor.*—The date of Scopoli's name is given as 1896; it should be 1786.

p. 216. *Chalcophaps indica.*—The occurrence in Kashmir of this bird seems to be founded on error. Adams recorded a pigeon in Kashmir and Col. Ward suggested that it might be *Chalcophaps indica.* No one has met with it in Kashmir.

p. 218. *Columbinae.*—Here again there is a muddle over the date. On p. 218 it is said that Selby designated the type of the genus *Columba* as *palumbus*, in his *Ill. Brit. Birds.* in 1852; on the next page the same is quoted under the date 1925. Both are manifestly wrong. The date is important as Vigors in 1825 designated the type as *œnas.*

p. 219. *Columba livia livia.*—The Rock pigeons are admittedly a difficult group, but it seems very improbable that this race has ever occurred in N. W. India. Rock pigeons are very sedentary

birds and if the typical race normally occurs no nearer than North Persia, it is inconceivable that it should wander over 1,000 miles into N. W. India. In the past it has of course often been recorded but it was not then recognized what a variable race *neglecta* is, some specimens being barely distinguishable from *livia*.

p. 225. *Columba œnas*.—The date is of course 1758, not 1858. This seems to me a very different pigeon to *eversmanni* and besides the difference given it has darker wings and rump, and grey-blue under wings instead of white.

p. 226. *Columba œnas eversmanni*.—The fact that this pigeon seems so distinct from the European one and that Persian examples of *œnas* are in no way different to European ones makes me hesitate to accept *eversmanni* as a race of *œnas*. Though *eversmanni* is said to breed freely in the Hari Rud in the extreme N. W. Afghanistan, Zarunday's records of this bird breeding in North Persia are founded on three specimens near Meshed and Faizabad which with no certainty were breeding. As regards British Beluchistan, there is no record of the bird at all either breeding or in winter though it surely must occur in the latter season. Is it certain that Barnes found this bird breeding in Afghanistan? He did not record it in his papers in *Stray Feathers*.

p. 228. *Columba p. casiotis*.—This also breeds in the juniper forests of North Beluchistan as I pointed out (*J.B.N.H.S.* xxxii, p. 73).

p. 236. *Streptopelia turtur turtur*.—The date should be 1758, not 1754. This bird finds a place in the *Fauna* on a single example obtained at Quetta by Swinhoe. I have examined this bird and was of opinion that it could not be separated from some examples of *arenicola*. It would seem more satisfactory to give the benefit of any doubt over a single bird to the more likely race to occur, as Quetta would be well over 1,000 miles beyond the range of the typical form.

p. 238. *Streptopelia turtur arenicola*.—The distribution given is not clear. Are all these countries and districts places where the bird has occurred? or is it supposed to *breed* in all of them.

p. 238. *Streptopelia orientalis*.—No one ever seems to agree on this group of Doves and it leads to endless muddle! *Orientalis* is fairly clear, but the difficulty arises over the other two. Skyes described a bird from the Deccan as *meena*. Hartert (*Vog. Pal.*, p. 1490) gives reasons for believing that *meena* was the race that breeds in Turkestan. Baker, however, thinks *meena* is the resident N. E. Indian bird for which Hartert uses Tickell's name *agricola*. Baker uses *ferrago* for the Turkestan form. If it is doubtful what *meena* refers to, it is best dropped altogether since it was described from a locality where all three races are said to occur in winter. *Ferrago* can then be used for what is certainly the Turkestan bird and *agricola* for what is certainly the N. E. Indian bird.

p. 240. *Streptopelia o. ferrago*.—The variation in wing length seems very large for a bird of this size—169-200 mm. Are any adults as small as 169 mm., 18 mm. shorter than the minimum given by Hartert? It is said that Stevens records this bird in Sikkim, down to 4,500 ft.; but in his paper on the Birds of Sikkim he

expressly states that *ferrago* (=*meena* apud Hartert) does not occur in Sikkim at all but that *meena* (= *agricola*) and *orientalis* occur and intergrade.

p. 241. *Columba chinensis*.—The date of Scopoli's name should be 1786, not 1844.

p. 243. *Streptopelia chinensis suratensis*.—I have searched in vain for any certain record of this bird in Sind. It does not appear to occur in Sind or in S. W. Punjab.

p. 247. *Streptopelia senagalensis ermanni*.—Here again Mr. Baker attributes to me statements I never made. I never said that this bird either occurred or breeds in Sind. I said that *possibly* it occurred, but that the breeding birds were *cambayensis*. *Ermanni* is the Turkestan race and the minimal wing length of Turkestan males is 135, a wing length attained by no Sind breeding birds. The maximal wing length of *cambayensis* is 132 and Sind birds are well within that limit. It is, moreover, unlikely that Sind birds should be the Turkestan race as the type locality of *cambayensis* is only just across the Runn of Kutch less than 200 miles away. Beluchi birds and stragglers to Iraq I have already shewn (*B.N.H.S.J.*, xxxii, p. 73) are all much too small for *ermanni* and are indistinguishable from *cambayensis*.

p. 254. *Macropygia u. tusalia*.—Mr. Whistler informs me that this bird does not occur at the present day in Kashmir or in the Punjab including Simla Hill State.

p. 263. *Pterocles orientalis*.—Here as elsewhere throughout the *Fauna* Barnes' records are referred to Afghanistan. It is quite true that Barnes, who was at Chaman about the time of the Afghan War, recorded his observations as being made in South Afghanistan, but for a great many years now Chaman and the Kwaja Amran have been within the Beluchistan Agency and so all Barnes' records really refer to Beluchistan.

p. 265. *Pterocles leichensteini arabicus*.—So far as present material shews, this race is not recognizable. There are but four topotypes of *leichensteini* in the British Museum and these, when placed with a series of Sind birds, are to my eyes quite inseparable.

p. 302. *Gallus lafayettii*.—'This *species* is apparently polygamous and takes no interest in eggs or chicks'. Surely this attribute only applies to the male.

p. 316. *Phasianus rufus* Raffles.—The date should be 1822, not 1882.

p. 318. *Euplocamus diardi*.—The date should be 1856, not 1886.

p. 320. One gathers from the remarks at the top of this page that the Kalij and Silver Pheasants in Burma are, owing to lack of adequate material, in rather a hopeless state of chaos. Numbers of these birds must be shot every year by sportsmen in Burma and it is a reproach to them that after all these years there is not yet an adequate number of specimens in the British Museum to elucidate the very complicated matter. If every sportsman would make it a matter of honour to send in, say, three pair of birds from his district, even if flat skins, together with some field notes, the questions of distribution, species and races could be decided. Surely our Society should be able to organize this.

p. 324. There is a reference here to *G. albocristatus* which might puzzle some people, since on p. 320 the bird is called *G. hamiltoni.*

p. 332. I wonder when anyone will bring forward satisfactory proof that an old feather can change colour by absorbing fresh pigment. Such a phenomenon has been stated to take place in a number of instances by many authors. Some alleged cases I have investigated and in each case I have found proof to be lacking. Possible errors are many and the instance here given by Mr. Baker does not add any proof at all. From the examination of the quill of an old feather, it would seem inconceivable that fresh pigment could be absorbed through it. Yet, if a feather can so change colour, proof would not be so very difficult. If an aviculturist would select some feathers in which he anticipates such a change will be going to take place and mark such feathers distinctly and infallibly and match them with feathers which can be kept for reference, then, when and if the marked feathers change colour, proof positive will be attainable and not until.

p. 333. *Gennæus rufipes.*—The type locality omitted is Mogok, Ruby Mines District.

p. 341. *Key to Genera.*—This fails at L. 4. 'Flanks not barred . . . . Francolinus' as the flanks are barred in several of the Francolins.

p. 375. *Tetrao coromandelica, Gmelin.*—The date omitted should be 1789.

p. 379. *Perdicula asiatica argoondah.*—The explanation that this is a race of *asiatica* inhabiting over a large area usually rather a different terrain side by side with typical form hardly tallies with the accepted idea of a geographical race and I can think of no other parallel case. The collecting of a few paired birds in various parts of the range might help to elucidate the question; but as it stands at present, we must look upon these two birds either as two species or else as dimorphisms of one species.

p. 391. *Arboricola intermedia,* Blyth.—The reference should be *J.A.S.B.* xxiv, p. 277, 1855.

p. 402. *Alectoris graeca.*—It may be true that *chukar* is not found in any sort of forest and I always thought this to be true of all forms of *graeca.* I was astonished therefore to see odd birds of *Koriakovi* in thick juniper forest in North Beluchistan and was told by the Assistant Commissioner there that in good years numbers might so be met with. Ten brace would be an exceedingly poor bag of Chukor in parts of Beluchistan. In the very bad season of 1919 three of us got 27 brace in a morning's shoot, where in some years 100 brace or more were easily obtainable. I quite agree that *Kirthari* is not separable.

p. 406. *Ammoperdix griseogularis.*—I cannot agree that *termeuleni* is a good race as I have already pointed out (*B.N.H.S.J.*, May 1926). It was described from S. W. Persia on the borders of S. E. Mesopotamia and not from Arabia and West Mesopotamia as suggested. Pale grey birds and more sandy-red birds occur together in many parts of the range of *griseogularis,* including S. W. Persia.

p. 410. *Francolinus f. henrici.*—Under this race Mr. Baker

includes all Black Partridges from Sind westwards to Baghdad. Iraq birds (*arabistanicus*) are of the same colouration as Sind birds but in wing length are larger, 14 Iraq ♂♂, W. 163-178; 11 Sind ♂♂, W. 155-162. Therefore I can hardly see how these two races can be united. I have already pointed this out (*Ibis,* 1924, p. 512 and *B.N.H.S.J.*, xxviii, p. 388). Western Mekran birds seem just separable (*bogdanowi*) from Sind birds by their paler colour and paler neck ring (see *B.N.H.S.J.*, xxxii, p. 76).

As regards the terrain of *henrici,* I do not think this differs much from that of other races. In Sind one would never find it in dry and arid areas but always in cultivation, tamarisk and grass jungle.

p. 422. *Francolinus p. mecranesis.*—The range of this bird is difficult to decide and probably no two people would agree about it. The ranges of this race and *interpositus* are continuous and intermediates are found. Thus some birds from Lower and Upper Sind appeared to be intermediate between the two and others nearer *interpositus.* I have seen no Sind birds however in any way approaching typical *pondocerianus.*

The Grey Partridge occurs up the Bolan to Kundilani and in the lower hills of the Bugti and Marri country and reaches the Loralai district. In Quetta, however, it certainly does not occur at the present day, nor have I ever heard of it occurring there in the past.

p. 434. *Lerwa lerwa.*—The Snow Partridge is said to occur between 12,000-17,000 feet; there are no hills of this height in Beluchistan and it certainly does not occur there.

p. 455. *Hemipodus plumbipes,* Hodg.—The date is omitted.

p. 448. *Turnix suscitator isabellinus,* 1928.—A very much older name for this bird is *Turnix bengalensis* (*Blyth Cat.*, p. 256, 1852).

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p. 33. It is not quite clear on what grounds *Porphyrio poliocephalus seistanicus* is omitted from the Indian Fauna. It is true that it has not occurred so far in India proper but only in Beluchistan, but the same may be said of *Strix butleri* and *Puffinus tenuirostris* both of which find a place in this work.

p. 40. *Metapodius indicus.*—No type locality is given; it should be India.

p. 49. Foot note.—The date should be 1928 not 1728.

p. 63. *Otis tetrax orientalis.*—The status of this bird needs investigation. Blanford stated that it was common round Peshawar in winter and the same is in effect said in the present *Fauna.* Is it really so or has there been a confusion of species? Mr. Baker says it is rare south and west of the extreme north-west or Trans-Indus country. Further on, however, he states that it winters in sufficient numbers in British Beluchistan (which certainly lies to the south-west of the country indicated) for bags of ten or a dozen couples to have been made in a day! Where in British Beluchistan have these remarkable bags been made and by whom identified? I cannot help feeling that some other Bustard has done duty for these 'records'. I could only find one certain record for the whole of Beluchistan. (*B.N.H.S.J.* xxxii, p. 79.)

p. 64. *Otis nigriceps.*—The Himalayas can hardly be the type

locality since the bird does not occur there. Foot-hills of N. W. India may be substituted.

p. 67. *Otis macqueenii.*—Here too the type locality cannot be the Himalayas. I suggest the foot-hills of N. W. India as more likely to be correct.

p. 68. *Sypheotides and Houbaropsis.*—Two genera here seem to be quite unnecessary. If we accept 'a seasonable change of plumage', by which apparently a pre-nuptial moult producing a distinct dress is meant, as a generic character then several species of birds usually placed in one genus would have to be split up. Thus *Muscicapa striata* and *M. hypoleuca* would have to be put into two different genera, since *hypoleuca* has a distinct breeding plumage. So too *Saxicola rubetra* moults into a breeding plumage, *Saxicola rubicola* does not. How too should the Wheatears be split up? We have *isabellina* and *oenanthe* with fairly complete spring moults producing hardly any change of dress in the former and a distinct dress in the latter; *leucura* and *picata* with no moult and hardly any change of plumage; *hispanica* and *leucomela* with only a few feathers shed and a remarkably different breeding dress.

p. 87. *Cursorius coromandelicus.*—For description of chick omitted here, see *B.N.H.S.J.*, Aug. 1926, p. 10. It is not quite true to say that this Courser is absent from the pure desert of Sind. I have found it constantly in pure desert, rather patchily distributed and rather partial to stony desert (*Ibis,* 1923, p. 649).

p. 88. *Rhinoptilus bitorquatus.*—Blyth obviously could not have described this bird under this name in 1848 if the generic name dates from 1850 or 1852. Blyth called it *Macrotarsius bitorquatus.*

p. 90. *Glareola pratincola pratincola.*—The chick (omitted) is described in the Journal (Aug. 1926, p. 11). The paragraph under 'Habits' seems to have got a little mixed. The birds are here called Coursers and the rest of the paragraph deals with habits so opposed to those of the Pratincole that one can only suppose that it really does not relate to this species at all.

p. 96. *Stercorariidae.*—Does not *Megalestris antarctica* occur within Indian limits? Nicoll has recorded that there are two specimens in the Colombo Museum from Ceylon and that he saw one off the south-east of that island in 5°. 23′ N. 84°. 45′ E. Wait also records these two birds and further states that *M. antarcticus maccormicki* has also occurred in Ceylon.

p. 99. *Stercorarius pomarinus.*—A further specimen is recorded from Ceylon by Wait.

p. 101. *Larus ichthyaetus.*—The date of Pallas' name is 1773, not 1733.

p. 102. *Larus ridibundus.*—The type locality (omitted) is Europe. Is not the bird from the Far East recognizable as *L. r. sibiricus.*

p. 104. *Larus brunnicephalus.*—There seems to be a slight slip here. 'Nidification' appears under 'Distribution' and the distribution of the species has been omitted.

Larus hemprichi.—The building of 'Crow-like' nests by this species needs verification. The origin of it was the attempt of Col. Butler's boatmen to describe to him the nests on Astola. Sir Percy Cox, the only ornithologist who has seen nests on Astola,

gave me quite a different account of the nests. (*B.N.H.S.J.* xxxii, p. 86).

p. 106. *Larus genei.*—By a curious slip the Persian Gulf is called the Corsican Gulf! This bird does not breed in Sind so far as we know at present. The colony at Sonmeani is in Las Belas.

p. 109. *Larus argentatus cachinnans.*—The winter dress of this bird is far less streaked on the head than is the winter plumage of *taimyrensis.*

p. 111. *Key to species of Chlidonias.*—This is obviously wrong, 'culmen over 33 mm.' and 'culmen under 33 mm.', as in both species the culmen is under 33 mm. in length.

p. 114. *Childonais l. leucoptera.*—The distribution given is a little mixed. It is stated that this Tern migrates to all Western India; two lines further down it is stated to be common all down the *east* coast and very rare elsewhere. Has it occurred in the West of India at all? There seems to be a large gap in the distribution of this Tern. It is rare or unknown between the head of the Persian Gulf and the East coast of India.

p. 116. *Hydroprogne c. caspia.*—This Tern might perhaps breed on the islands adjacent to the Mekran coast if there are any. Butler and Hume mention none except Astola, nor did I see any in four trips along that coast, nor do any maps I have access to shew any.

p. 117. *Geochilidon n. nilotica.*—The Gull-billed Tern may of course breed freely on the rivers of N. W. India, but it has been recorded remarkably few times. Waite found a small colony in the Beas and Hume and Whistler single nests.

p. 122. *Thalasseus bergii bakeri.*—This race requires 'the eye of faith' to differentiate from *velox.* I can see no constant difference.

p. 129. *Sterna repressa.*—This Tern may of course breed and be resident on the Sind and Mekran coasts, but I know no proof of it. In Sind it has been obtained by Butler in Karachi harbour in April and off the Mekran coast he met with large numbers in May. No one else appears to have recorded it and certainly no one has ever found it breeding. All the evidence tends to shew that this bird is a migrant along the coast to its breeding grounds in the Persian Gulf. It does not breed on Astola so far as is known and the other islands adjacent to the Sind and Mekran coasts have yet to be found and explored.

p. 130. *Sterna hirundo.*—There seems to be very few certain records of the Common Tern in India and it certainly does not winter, as suggested in N. W. India. Hume remarked on this as long ago as 1873. Butler met with it in Spring in Karachi Harbour and I have seen non-breeding birds there throughout the hot weather and met others on passage in August.

p. 131. *Sterna hirundo tibetana.*—Surely this bird is not a very common visitor to the whole of Western India as stated here. Who has met with it? There are no records of it in Sind and the Punjab.

p. 131. *Sterna hirundo longipennis.*—I do not feel at all sure that this bird is a geographical race of the Common Tern. Does it intergrade anywhere? Moreover, both occur on the Yenesei River. The exact breeding ranges of *hirundo, tibetana* and *longipennis* want working out.

p. 134. *Sterna albifrons.*—I have already dealt at some length with this group (*Bull, B.O.C.* 49, p. 66); so need not do so again at length. I have already shewn that the Ternlet breeding in N. W. India is *S. albifrons albifrons,* and not *pusilla* (whatever that may be and opinion does not seem decided). In the distribution here given, there seems a huge overlap of range of *sinensis* and *pusilla,* both occurring throughout Malaya. The breeding bird of Mesopotamia I consider to be *S. albifrons albifrons* and I have recorded it as such and I have given reasons for considering *praetermissa* to be a synonym. I cannot quite make out what is meant by 'the marshes of the Northern Mekran coast'. The only place for certain that any Ternlets breed is on the Sirunda Jheel in Las Belas, but there seems to be no breeding birds thence available for examination, though I have a nestling. Mr. Baker identified eggs thence as *saundersi* and subsequently a parent bird as *albifrons,* as Mr. Ludlow informed me, and now it is said to be *praetermissa* !!! Even if this latter bird were recognizable, it should bear the prior name of *innominata* of Zarudny.

p. 139. *Sterna albifrons saundersi.*—Though this Tern *may* breed on the Mekran coast no one has so far proved that it does so. In fact when I wrote the *Birds of British Baluchistan* there was no certain record at all of the bird in British Mekran and I do not think it has been got since. It does not seem possible that *praetermissa* and *saundersi,* if both are races of *albifrons,* can both breed on the Mekran coast. The average length given for the eggs of this bird should be 31·7, not 21·7.

p. 146. *Anous stolidus pileatus.*—If British Mekran is included in the *Fauna,* and sometimes it seems to be, there are records of this bird thence. (*J.B.N.H.S.* xxxii, p. 88.)

p. 157. *Squatarola s. squatarola.*—To say that this bird is more common on the coastal districts than inland hardly gives a correct impression of the status. Does it occur inland at all? Even in well searched maritime countries of England such as Norfolk and Suffolk, it has hardly ever occurred inland.

Squatarola s. hypomela.—This seems to be a new variation of Pallas' name. Pallas wrote *hypomelus* apparently by mistake for *hypomelas* and the feminine should surely be *hypomelaena?*

p. 160. *Eupoda vereda.*—It is a far cry from Mongolia and North China, where this bird is supposed to breed, to Ladak. Ladak has of late been visited by several ornithologists and this species has not been met with by any of them. When Dr. Hartert wrote of this species in his *Vög. Pal. F.* (1920) the nesting of this bird was apparently unknown and this supposed egg from Ladak is the first recorded. It seems very unsafe to base records of breeding for the first time and description of the egg on the evidence of a scrap of skin since this bird, according to Hartert, is only a race of *asiaticus.*

The Andamans bird was obtained by Dr. Dobson, not Dr. Adams.

p. 164. *Leucopolius peronii.*—If this is not considered to be a race of *alexandrinus,* it hardly seems correct to call it a Kentish Plover; nor is it clear why it finds a place in the *Fauna* at all; no part of India is included in its distribution.

p. 169. *Charadrius hiaticulus*.—Linnaeus wrote *hiaticula* and this should not be altered as it is obviously a substantive.—*Charadrios sive Hiaticula* of Aldrovandus. The distribution given implies that this bird is common in India, whereas it is excessively rare.

p. 171. *Charadrius dubius curonicus*.—This race certainly breeds in the Quetta district.

Charadrius dubius jerdoni.—The type locality should be Ceylon and the date should be 1880. The reference given here relates to *hiaticuloides* Franklin.

p. 175. *Cirrepedesmus leschenaultii*.—The date of this name should be 1826, not 1836. The wing length I measure in 17 of both sexes as 139-150. The bill measurements given here only apply to males; females have longer bills, 25-27 mm. It seems very strange that, if this bird breeds in Japan, that its nidification should be unknown; there must be few birds whose breeding range is *apparently* so well known but of the actual nesting nothing known. Matthews, however, in his *Birds of Australia* refers to Mr. Baker as his authority for the nesting and description of an egg of this species (also identified by a scrap of skin) from the Tso Morari Lake in Ladak. Is there then some error about this as it is not mentioned here?

p. 173. *Cirrepedesmus*.—This genus seems to be quite untenable. In it the bill is said to be decidedly shorter than in *Charadrius*; but in *Cirrepedesmus leschenaultii* the bill is *longer* than in any member of the genus *Charadrius*, while the bills in *placidus* and *atrifrons* are about equal, the measurements given here for the latter being too small. *Pagoa* is of course an utterly unrecognizable genus, as *Cirrepedesmus atrifrons* and *leschenaultii* are linked together by *Cirrepedesmus leschenaultii columbinus*.

p. 179. *Vanellinae*.—In the key to genera *Recurvirostra* appears in a group distinguished as 'Bill curved *downwards*' ! !

p. 183. *Chettusia leucura*.—In the juvenile dress, if that is what is meant by 'young birds', the underparts are not at all like those of the adults; they are sullied white.

p. 185. *Hoplopterus ventralis*.—Does not occur in Kashmir.

p. 186. *Lobivanellus*.—It is here stated that in this genus and in the next (*Lobipluvia*) there is a small hind toe present but on p. 189 under the generic characters *Lobipluvia* is said to have *no* hind toe.

p. 191. *Microsarcops*.—The date for this genus is 1896, not 1886.

p. 193. *Himantopus h. himantopus*.—The description of the 'young male' given is certainly not that of the juvenile plumage. It appears to be a sub-adult stage or a variation of the adult plumage.

p. 195. *Recurvirostra a. avocetta*.—Though the habits given refer to the Avocet, the bird is by a slip called the Stilt.

p. 201.—*Numenius arquata arquata*.—One gathers from the distribution that this is a common bird in N. W. India. If it occurs surely it is only as a vagrant. India is a long way out of its normal distribution and all the Curlews Mr. Whistler and I got in the North-west were *lineatus*.

pp. 205-8. *Limosa limosa.*—In the key the maximum length of the culmen in *melanuroides* is given as 87 mm., but on p. 208 it is given as 95 mm. On the measurements given, the wing lengths of the two forms would provide a better key. The winter plumage described is that of a juvenile. In *L. limosa* the bill of the female is, as is well-known, longer than in the male; in *melanuroides* the male appears to have the longer bill. Is this really so?

p. 209. *Limosa l. lapponica.*—Here again the description of the winter plumage is really that of the juvenile; the winter plumage is quite different. Females, if they assume breeding dress (and there are always some birds of both sexes which do and do not breed in that year), always, so far as I have seen, don a *complete* breeding dress; but this is not at all the same as that of the male. The habits in autumn and winter are different to those of the Blacktailed Godwit as the latter is a fresh water bird, the Bartailed Godwit is eminently a salt water species.

Limnodromus.—This name is antedated by *Macrorhamphus* of Forster, 1817. It is not clear why Blyth's prior name *semipalmatus* has been dropped. *Scolopax semipalmatus* of Gmelin does not invalidate it.

p. 213. *Xenus cinereus javanicus.*—This is another race which needs the 'eye of faith'. I could see no colour differences to distinguish European and Far Eastern birds and I found the bills measured almost the same. Europe 43·5-49·5; Far East 44-51. (See also Riley, *Pro.U.S.Nat.Mus.* 54, p. 615.)

Xenus is surely the same word as *Xenos* and therefore cannot be used for the genus, owing to prior use of the latter name. (cf. *Apus* and *Apos.*).

p. 215. *Tringa ochrophus.*—I thought the correction of this error to *ochropus* had been accepted by everybody. Under 'nidification' the Green Sandpiper is referred to as the Marsh Sandpiper.

p. 217. *Tringa stagnatilis.*—I do not think this has yet been proved to breed in S. E. France. Surely this is not a seashore bird at all, I have never met with it on the actual shore and only very occasionally on salt pools at the heads of creeks.

p. 220. *Tringa glareola.*—The distribution and nidification have been omitted altogether.

Tringa totanus.—My examination of Mr. Whistler's breeding birds from Ladak leads to a different conclusion to Mr. Baker's. These Ladak birds I cannot match at all with a series of breeding birds from Suffolk. They stand out conspicuously different. If Suffolk birds belong to the typical race, then these Ladak birds do not. Moreover, these Ladak birds have very long bills—44·5-48 mm. as against 41-43·5 mm. in British breeding birds, and are much more heavily spotted on the under parts. Does any West European Redshank have a wing as short as 134 mm.? My smallest of a long series measures 154 mm.

p. 223. *Tringa totanus terrignotae.*—This race occurs of course also in N. W. India, but before *terrignotae* was separated, they were recorded as *eurhinus* (e.g. *Ibis*, 1924. p. 120).

p. 225. *Glottis.*—This genus seems unnecessary. If a recurved bill distinguishes this genus from *Tringa* why not distinguish *Erolia*

minuta, etc., with straight bills from the decurved bill of *Erolia testacea*, the type of the genus *Erolia*?

p. 228. *Philomachus*.—The Rules of Nomenclature infer that an author must have a name and under these circumstances it is difficult to see how an anonymous person can be accepted as an author. If my view is correct, then *Philomachus* cannot be used.

Philomachus pugnax.—This dichroism in the colour of the legs of the Ruff is very curious. Adults, so far as I have seen, have the legs distinctly yellow or distinctly greenish and in the young there is generally an indication of what the colour is going to be when adult. The first Ruffs arrive in N. W. India in the *first* week of August, the bulk come early in September.

pp. 230-1. *Crocethia*.—Vroeg did not describe any birds. Vroeg's catalogue names are accredited to Pallas who is therefore the author of the names and the date is 1764, not 1864.

p. 233. *Eurynorhynchus pygmæus*.—It is certainly not correct to say that nothing is known about the nidification of this bird. The nesting in the East Cape, N. E. Siberia was discovered so long ago as 1913 and recorded by Brooks (*Bull. Mus. Comp. Zool. Harvard.* LIX. 5, p. 382) in 1915 and the account duly finds a place in *Vög. Pal. Fauna*, p. 1603.

p. 238. *Erolia temminckii*.—This bird differs in habits from the Little Stint in one important particular. I have never met with it on the sea-shore nor heard of anyone else doing so. In fact I have never met with it in a salt water terrain at all, whereas the Little Stint may be found on both salt and fresh waters.

p. 244. *Calidris tenuirostris*.—A few notes on the habits of this bird may be found in *S.F.* i. and *Ibis*, 1924.

The Common Knot does not find a place in the *Fauna*. One is recorded from N. Beluchistan (*B.N.H.S.J.* xxxii, p. 83) and another from Ceylon on December 15, 1923. (Wait, *Birds of Ceylon*, p. 375.)

p. 248. *Phalaropus fulicarius jourdaini*.—In an authoritative work like the *Fauna*, I think it is expected that no bird should be listed as occurring within our limits over which there can be any reasonable doubt. It is quite true that Blyth obtained a single Grey Phalarope in winter dress at Calcutta, but it must be pure surmise that the race of Grey Phalarope he got was *jourdaini*. Apart from the question whether this is a good race or not, no one, even the author of it, pretends he can distinguish it in winter plumage. Such records are far better left under a bionomial name.

p. 250. *Phalaropus lobatus*.—I can recall no Wader which skips a winter plumage and goes straight from juvenile dress into breeding plumage and if this Phalarope did so, it would be very remarkable. However, it does not do so as I have in my collection a young bird in full winter dress with a grey mantle, and a juvenile moulting into winter plumage. Here, as so often in the *Fauna*, the 'Habits' given apply to the breeding season even when the species does not breed in India. The habits of this Phalarope as seen in India were fully described in the *Ibis*, 1924, p. 126 and *J.B.N.H.S.* xxxii, p. 83.

p. 261. *Capella gallinago raddii*.—The distribution is omitted. This seems a very questionable race. It must be remembered that

the European Snipe is paler in summer, a season when few are obtained, than in autumn, whereas this is the season when *raddii* have been got. The axillaries seem variable; thus I have seen English birds with almost unbarred axillaries. On the other hand, Riley records birds from Nijni Kolymsk, which ought to be *raddii,* as being 'as heavily barred as in any European Bird on the axillaries.'

p. 265. *Capella megala.*—This bird occurs in Upper Burma as I had a tail sent me thence for identification in 1923.

p. 271. *Pelecanus onocrotalus onocrotalus.*—It is not correct to say that I could not determine which Pelican breeds in Iraq. In *B.N.H.S.J.,* May 1926, p. 19, I stated that adults from the colony on Bubyan Island off Fao were *onocrotalus,* the typical race. Mr. Baker decides that their chicks and eggs belong to *roseus.* On p. 272, he says the young of *roseus* is indistinguishable from that of *onocrotalus* and I suggest that the chick is too. Nor am I convinced that one can differentiate eggs of these two races. On the measurements here given, it will be seen that the smallest eggs of *onocrotalus* are far smaller than the largest eggs of *roseus* and indeed smaller than the *smallest* eggs of *roseus,* so that by measurements there must be a number of eggs which might belong equally to either race.

p. 280. *Phalacrocorax fuscicollis.*—'On the Mekran and South coasts all three species of Cormorant may be seen fishing in the sea'. As regards British Mekran, this bird *probably* occurs, though no one has so far recorded it. *Ph. niger* certainly occurs in the valley of the Mashkai and probably elsewhere in the few places where there is sufficient fresh water. But does it really occur at sea? Who has obtained it? Has anyone ever seen this bird at sea anywhere?

p. 283. *Anhinga melanogaster.*—'West to Mesopotamia'. I went very fully into the question of the Darter in Mesopotamia (*B.N.H.S.J.,* xxviii, p. 327) and shewed that it is the African *rufus* which occurs there and not the Indian bird. I confirmed this again (t. c. May 1926, p. 19).

p. 285. *Sula leucogaster plotus.*—To the distribution may be added 'several times in Ceylon'. (Wait.)

p. 288. *Sula d. melanops.*—It is rather amazing to learn that the nestling in down of this bird is known and here described when the 'breeding haunts have not been discovered'. How was the chick obtained?

pp. 292-3. *Phaeton rubricauda* and *Ph. lepturus.*—Have these birds really been obtained in the Persian Gulf, and by whom?

p. 296. *Fregata andrewsi.*—Also twice in Ceylon (Wait).

p. 297. *Fregata minor aldabrensis.*—Nicoll neither met with this bird nor recorded it from Ceylon. There is, however, a bird in the Hume collection from Neville.

p. 299. *Tubinares.*—A confusing word *Puffinidae!* Here they are called Puffins instead of Shearwaters.

p. 301. *Oceanites o. oceanicus.*—One is also recorded from Ceylon Nov. 1908 (Wait).

p. 304. *Puffinus pacificus hamiltoni.*—I have already pointed out (*B.N.H.S.J.,* xxxii, pp. 89-90) that the bird recorded by Cumming as *chlororhynchus* from Ormara in May 1899 is the same bird as

that also recorded on 305 of the *Fauna* as *P. tenuirostris* obtained by Mr. Walter Scott, and that the latter identification is correct.

p. 375. *Phoenicopterus r. antiquorum.*—'Their method of feeding is curious; their long heads are bent down *between their equally long necks*'! Extraordinarily curious!! I quite missed this remarkable phenomenon when in India.

p. 378. *Anseres.*—Here is a point to which Indian ornithologists might pay attention—which, if any, of the Indian *Anseres* cast their flight feathers in pairs instead of simultaneously as European Ducks and Geese do?

p. 398. *Anser anser.*—Surely the colour of the bill in life is never livid purplish red but only after death and due to stagnation of blood?

p. 401. *Anser erythropus.*—The goose which breeds in Persia and whose young are brought into the bazaars is certainly *Anser anser* (specimens examined) and not *erythropus.* I know of no record of this bird in Sind and in fact I should accept no record of this bird at all in India unless a specimen or head was forthcoming as it has been so frequently mixed up with *albifrons.*

p. 403. *Anser brachyrhynchus.*—Is there any specimen of this goose from India in existence? If not, it should be deleted from the *Fauna.* The Pink-footed Goose is a bird of rather limited and distinctly westerly distribution in winter at which season, according to Buturlin, there is not a single record so far east even as European Russia. What the Goose obtained in Assam was with a bill of 40·6 mm. I cannot say; this is too small a bill for the Pink-footed Goose, 15 of which in my collection measure 43-50 mm.

p. 405. *Anser indicus.*—The type locality is India, not the Taimyr Peninsula. This bird does not breed in Kashmir proper, though of course it does so within the domains of the Maharajah of Kashmir.

p. 409. *Anatinæ.*—The *bulba ossea* is said not to be present in other sub-families *except in the Anserinæ;* on p. 396 it is stated that it is absent in *Anserinæ.* The latter statement is correct.

pp. 416-7. *Anas ferruginea.*—Described by Pallas, not Vroeg. The rather sketchy description of the nestling in down does not convey the fact that the chick of this bird only differs constantly from the chick of *tadorna* in that the lores are of the same colour as the crown whereas in *tadorna* the lores are white.

The relationship between the two birds is therefore so close that two genera seem to be unnecessary. The old legend of the Brahminy eating human bodies is revived again. Has this ever been proved by a trustworthy witness?

p. 426. *Eunetta.*—The splitting up into many genera or the lumping into one or two is, I suppose, in this group and in other groups, a moot point on which there never will be any agreement. Thus Mr. Baker in the *Fauna* uses eight genera for ducks where Dr. Hartert in the *Vög. Pal. Fauna* uses one genus. It is not without irony that both are members of a Committee appointed to try and produce some uniformity in nomenclature.

p. 428. *Chaulelasmus streperus.*—The nestling in down also

differs from that of the Mallard in having the yellow supercilium not nearly so well marked.

p. 430. *Mareca penelope.*—The diagnostic character of the downy chick is the cinnamon face which no other young duck has so far as I have observed.

p. 435. *Nettion formosum.*—Add one from Sind (vide *Ibis,* 1923, p. 451).

p. 439. *Querquedula.*—Two genera for the Teals seem unnecessary and untenable. *Querquedula* is said to have a broader bill than in *Nettion* with the width greater at the tip than at the base. The bill in *Nettion formosum,* however, is broader than in *Q. querquedula.* The broadening towards the tip in the Garganey moreover is not constant. I have specimens in which the sides are parallel throughout their entire length. The shape of the bony labyrinth certainly is not a generic character, as every male species of duck has a different one.

p. 447. *Nyrocinæ.*—Another good character between these and the surface feeding ducks is the much larger *bulba ossea* in all diving ducks.

p. 448. *Anas rufina.*—The date of Pallas' *Reise* is 1773, not 1833. This duck has not, I think, been found breeding in British Beluchistan.

p. 460. *Nyroca f. fuligula.*—In England at all events the Tufted Pochard is far more partial to fresh water than salt; in fact, in my experience it only goes to salt water when frozen out from fresh.

p. 471. *Mergus merganser merganser.*—This Goosander, the typical form, *may* of course occur in Sind. I purposely left the question undecided in my *Birds of Sind* as no specimens are in existence. Under such circumstances, I prefer to leave the race as unknown and use the binomial name. Such a course is at least accurate and is not open to the objection that possible errors will be copied.

Surely in the non-breeding season the Goosander is far more a fresh water than a sea bird?—exactly the opposite to the Redbreasted Merganser.

p. 486. *Colymbus arcticus suschkini.*—Mr. Jones recorded this bird merely as *Colymbus arcticus.* Has the skin been compared to determine the race? The wing measurement may be small, but surely by February 19 the bird would be fully grown.

I am at a loss to know whether British Mekran is included within the scope of this work or not. Several birds such as *Strix butleri* find a place in the *Fauna* on the strength of records thence; others are omitted. There is in the British Museum a specimen of *Colymbus stellatus* obtained at Ormara on November 17, 1901. (*J.B.N.H.S.,* xxxii, p. 96.)

HOW TROUT WERE INTRODUCED INTO KASHMIR

BY

F. J. MITCHELL

Readers of the *Journal* may have seen Col. Godfrey's account of 'How British Trout came to Kashmir' in the *Fishing Gazette* of 13th July last. After 30 years, individual memories are rarely complete and I regret he has omitted any mention of my brother Willie and of my old friend Capt. Allan, both alas! now passed away, whose subscriptions and efforts to raise a fund for the purpose in the summer of 1899 preceded the meeting he refers to.

Col. Ward was at that time my brother's partner in a roadmaking contract and Col. Unwin, a close personal friend, and both had promised their subscriptions before Col. (then Major) Godfrey came into the picture. I quite appreciate that without the support of the Residency and the Duke of Bedford's very generous gifts and subscriptions, it might have been impossible to carry through the scheme efficiently, as, though Col. Ward's influence with the Maharajah was most useful, he himself was not a great believer in success, owing to the failure of similar attempts in other parts of India, of which he knew. Beyond subscribing he took little interest in the work of the early years after the importations of ova, presented by the Duke of Bedford in 1900 and 1902, but, I am glad to say, enjoyed some excellent fishing in the Dachigam Rukh after 1906.

To explain how I came into the matter I would mention that, after 17 years spent in India, including a few months in Ceylon, where my brother-in-law was one of those who first brought brown trout into the Island, I had returned from the East and spent nine years in Great Britain, where in much of my leisure throughout this period I enjoyed the company of experts of the rod on the lochs and streams of Scotland.

When I left India in 1890, it was possible to dine in the Yacht Club at Bombay in flannels after a sail, and on a farewell visit to my brothers in Kashmir in the Spring of that year, I found that it was possible to dine at the Residency there, on occasion, in pattoos, garments made of rough local cloth of which I am still fond. I had to ride from Chekoti, where the driving road then ended, along a hill track to Uri and thence, on the new road to Baramoola. From there to Srinagar I travelled in a Doonga—a thatched boat in which my sleeping room was separated from the kitchen and servants' quarters by a wooden partition. I think only three house-boats, built by Sir Henry Lennard, Mr. Martin Kenard and Mr. Spedding were then in existence.

When I returned in May 1899, all was changed and dress was 'de rigeur' everywhere. The roads into the country—constructed chiefly by my brothers—had been completed, and I was able to drive all the way to Gupkar (1½ miles beyond the Residency) where my brother Willie had a house. The river and lakes were full of house-boats with parties of ladies and young men on leave, and gaieties were in full swing. To a man of 44 who has lost his money and has a family at home to support, the attractions of society are not great and I settled down to work at once. It was not very long however before I discovered, ten miles away, above the Srinagar water works, a lovely valley in which hill barbel swarmed in a stream flowing through beautiful woods and mountains. From this valley, then an open one, but closed as a game preserve in 1902, the craggy sides of Mahadeo (Great God) rose to 13,500 feet above sea level. Many a happy week end was spent there during and after the summer of 1899. My description of it as 'an angler's paradise, could trout be substituted for barbel', a transformation I believed quite possible, had probably something to do with my brother's action in enlisting subscribers and it was a great joy to me when I met Major Godfrey for the first time and heard of the Duke of Bedford's generous offer to send out ova if someone could be found to look after it. Very willingly I undertook the charge. Possibly, if the first letter thereafter to the Duke had contained more full instructions for shipment, a mistake might have been avoided, and had the first ova arrived safely when Capt. Allen went down to meet it in the spring of 1900, the whole history of trout in Northern India might have been altered.

As it was, the failure was looked upon by the State officials as the end of the business and practically all Major Godfrey's arrangements were cancelled. The Dilawar Khan Bagh, which had been placed at my disposal for hatchery purposes, was handed over to the Educational Department for a school, for which it was excellently suited. The Arrah River in the Datchigam Valley was no longer allowed to be a prospective club water, nor was any part of the Dal Lake to be netted off, or reserved in any way for trout. When I heard from Major Godfrey that ova was to come, I had to make my own arrangements and it was with considerable difficulty that I got the Srinagar Municipality to give me a connecting ½″ pipe from our carpet factory water-supply to the verandah of my dwelling house where I arranged the ova should be hatched out. The hatching box was placed within a foot of my bed-head, a thin wooden partition only intervening, and this proximity really saved the situation. Several times I was awakened by the stoppage of the flow of water and my men were promptly roused and despatched to bring cans of water, while an urgent messenger raced off to the municipal authorities. When the alevin stage was passed, a rearing pond was dug in the factory compound and the pipe connection was transferred there, but municipal failings still continued, though at longer intervals, and were less quickly detected. I well remember taking a plate with half a dozen little beauties of 3″ to 5″ which had perished during one of these lapses, to the Resident, to whom I poured out my indignation. Col. Deane (afterwards

Sir Harold, Chief Commissioner of the N. W. F. P.) was not a man to pass over that sort of thing and it didn't occur again. He really became interested in the work and, though he considered the State should not alienate their water, he suggested I should begin operations by stocking the Arrah River, in what was to be the Datchigam Rukh area. To this I objected on the ground that neither I nor my friends, who had joined in raising money, would be allowed to fish there, but on receiving a demi-official letter from him stating that we should always have that privilege, I gave way. A stew pond was established in the Rukh area and the Arrah was the first river stocked.

When we first heard that ova was to arrive by the '*Caledonia*', funds were not over-plentiful and, with no club water, there was no prospect of obtaining more money from private subscribers. The Resident had given it as his opinion that the State should find funds at least equal to what had been subscribed by the club, but no response had been made to this. The Durbar no longer believed in the success of the scheme, and Colonel Deane's tenure at the Residency was to be a short one. The greatest economy was required. Someone had to go down to meet and bring up the ova, with an extra packing case in which it might be safely brought through the heat of Bombay, and a man must be found to attend to the ova while hatching and to have the care of the young trout up to the time they could reproduce their own species, three years at least, if no further hatchery arrangements were to be considered. Young James Sidgreaves Macdonell of Mora, who was with us at the time, undertook the first task and carried it through most successfully, arriving at the carpet factory late one evening in the Christmas week of 1900.

(I should here note my thanks to the late Capt. Kitchen of the 5th Gurkhas for a diary account he sent me of an unsuccessful attempt he had made to establish trout in a stream near Abbottabad under most difficult conditions in spite of which he almost reached success. The protective box in which the Laird brought up the ova was similar to the one Kitchen had used successfully.)

What an evening that was! We had gone through the misery of a fisherman's 'Paradise Lost' in spring and now we had before us the prospect of 'Paradise Regained'! After the Laird, as we called him, had his bath and some food, we started right away and spent most of the night transferring the ova from the moss packing in which it arrived to the glass grills of the hatching box sent out by the Duke, over which we soon had the water running from the $\frac{1}{2}''$ pipe. The new man was there, but of course he knew nothing and had to be instructed. Of him I have much to say, for the whole history of trout in Northern India bears his mark. Sodhama, a poor little red-haired pundit with a weak body but a clear steadfast mind, then doing odd jobs for Narain Dass, the boat builder, who was incidentally also the landlord of the ground on which the Carpet Factory was built, undertook the work originally on a pay of Rs. 5 per mensem, on the assurance that it would lead to better things if all went well. He knew no English, though curiously he was well read in Sanskrit, to which Kashmiri is probably more closely allied

than any other living language. Consumption had also attacked one of his lungs, a complaint very common among carpet weavers and other indoor workers in Srinagar—not, one would say, a very hopeful man for the job, but it was not long before he justified his selection. Col. Godfrey has not mentioned among his good services, the purchase and despatch to Kashmir of a book written by an early American Trout breeder, called *Domesticated Trout*, a book of the greatest value to us at the time, as the instructions were clear and could be translated for Sodhama's benefit and never, I am sure, had the writer a more intelligent and patient student. From the time the ova arrived, trout culture became his life work; but, though the healthy open air life cured his consumption, his remuneration in his native State has been a poor one. He wrote me the other day that he has nothing laid up for his old age. He is still only getting Rs. 30 * a month from the State and has, I fear, no hope of a pension. If the many sportsmen who now enjoy trout fishing in Kashmir and the Punjab knew and appreciated all he has done for them, they might do something for him now.

He took down the first ova and plans for ponds to Kulu and planted the first boxes of ova in sites in the streams which were selected by Mr. Howell with his help and advice. For this he had the Punjab Government thanks and a presentation watch in addition to his liberal *Indian* pay. He has done similar work for Gilgit Kangra, Abbottabad, Kistwar, Chamba, Naini Tal, Shillong and Sikkim, not to speak of Simla where trout do not appear to have caught on. An exchange of rainbow ova was also successfully effected with Ootacamund by him. Clear headed and careful, he has always carried through successfully work entrusted to him. Kulu now rivals Kashmir as a fishing resort.

His care of the ova in the hatching box and of the fry when put out in the stew pond was untiring and the growth of the little fish was amazing. I measured one yearling, which with a few other very big ones was turned out in the Arrah river in October 1900, $10\frac{1}{2}''$ in length.

When transferred to the pond excavated near Panchgam in the Rukh area, the young fish continued to grow well under his care. They were hungry for flies when Sir Louis Dane who succeeded Col. Deane as Resident paid a visit to the pond. Sir Louis was much impressed by their condition and promptly went into the question of finance with the State Darbar, so that funds were shortly forthcoming to carry on the work (just in time as the Club funds were practically exhausted). He took a keen interest in the trout work and some years later when he became Lt.-Governor of the Punjab, he arranged for their introduction into the Kulu Valley where their success has been wonderful. At the exhibition he held in 1909 in Lahore, he had an exhibit of trout hatching carried out and with the help of Sir Shri Krishna Gupta, who was then

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* Since writing this I have heard that, owing to the great advance in the price of rice in Kashmir, an allowance was made to all State servants drawing pay below a certain figure and that this has now been consolidated at 50 per cent. Sodhama's pay being now Rs. 45 per mensem.

working with the Secretary of State (Lord Morley), arranged for a travelling allowance to be given to Mr. Howell, who had been Assistant Commissioner in Kulu and had carried on the trout work there, to study fisheries in America during his leave. Departmental Fishery work was thus introduced into the Punjab and many fish have been saved from destruction during the contraction of rivers, whose water has been drawn off for the canals which in their turn have made millions of acres of desert into rich cultivated land.

Financial arrangements.—Col. Deane's view was accepted and supplemented by Sir Louis Dane when he had seen the ponds at Panchgaum (in the Rukh). A cheque for Rs. 2,000 was at once sent to me, and it was arranged that further sums required should be provided from the Game Preservation Department. As from the first, the accounts continued to be kept by a clerk in the Carpet office, who, as these became heavier, received a small monthly consideration for services so given. Accounts of all expenditure had to be rendered through the Game Preservation Department subject to audit by the State authorities. Estimates for the coming year also had to be prepared annually in time to be included in accounts presented to the State Council when the annual budget was under consideration with details of prospective expenditure under each head. This entailed a good deal of work for the clerk.

The great flood of July 1903 in Kashmir swept high over the pond at Panchgaum and nearly 1,000 trout which were expected to spawn that autumn lifted their noses into it with the joy of freedom, and with its subsidence settled down in the best pools of the Arrah River. No doubt some of them might have been netted out and spawned, in November, but as the floods had ideally cleaned the Redds, it was thought advisable to leave the fish alone and see how they would get on with their domestic arrangements under natural conditions—a new supply of ova being arranged for to start new ponds, with a view to spreading trout in other rivers of Kashmir, should success under natural conditions be proved. The result was satisfactory; for when the snow water had run off in the summer of 1904, little yearlings were found in gravels far below where the spawning had taken place, and some of these had passed through what was left of the burst reservoir, thus escaping the damage from native fish which had been freely prophesied for them.

By the request of the Durbar a new site *outside* the rukh had to be selected for ponds, and funds were provided to make them more suitable for the work than had earlier been possible.

The ponds were begun on the line of a small irrigation channel, a branch of one from the reservoir. Two small spring rivulets joined this and proved later of great value. Beginning with three ponds of $50' \times 5' \times 4'6''$ extensions down the channel were made as required; for the bigger fish, the width being doubled. The sides were of dry masonry faced with cement and the ends fitted with screens to prevent the trout escaping. Fry were a difficulty as they could escape through minute holes in the masonry and perforated zinc traps had to be arranged to catch those so getting through—an amazing number. Side channels to each pond made it possible to

clean them without stopping the whole flow. Possession of the channel was arranged with the villagers in the first instance without State assistance and after all had worked well for a year or two, everything was officially confirmed. A potter whose yard abutted on the area taken up, benefited, as visitors to see the trout were much interested in the working of his wheel and often bought some of the pretty though simple wares he produced.

Artificial Spawning Beds

Some 200 fish, reared from the 1902 importation of ova, had been kept in an artificial pond above flood level in the rukh. The water supply of this pond was from a fine spring which swarmed with gammeri, and it was chiefly on the crustacians descending from this spring that they had existed. The flood had for a time upset all other arrangements for feeding them. They were a fairly level lot, the biggest not exceeding 6 oz. in weight. In their new quarters, below the rukh, to which they were removed in July 1904, they were fed on small fish brought from the Dal Lake, and so quickly did they grow on this diet, that by October 1906, when Lord Minto visited Harwan, it was possible to present him with a fish of 12½ lbs., the fish in the ponds being all at this time 6 lbs., and upwards in weight. An earlier viceregal visitor, Lord Ampthill, when acting for Lord Curzon, had visited this new site shortly after this pond was made. Of the great house of Russell and kinsman of the Duke of Bedford, he naturally took an interest in the progress of the trout in Kashmir, but at the time of his visit the fish were small and few, and too many would have been required for a viceregal camp banquet. It was in this pond that the first attempt to obtain ova was made. As it was feared to damage fish by attempts to strip them by unpractised hands, an artificial spawning bed of rough gravel was arranged on rabbit wire, below which the ova coming through were trapped on perforated zinc trays. Rather over 2,000 ova were caught in this way. About 1,000 of these proving fertile were hatched out in the ordinary boxes and had reached the alevin stage and nearly to the fry stage when the lid of the box was one night left a little open and a water shrew got in. When morning came, he was found dead in the box with only one living fry as his companion. He had absorbed the 1,000 little fish and, so distended, could not get out and was drowned. The ova which arrived out that year was hatched in spring water in the open, protected by mats, as we had no hatchery till later.

From the very partial success of artificial spawning beds, it was evident that better methods must be taught and, when fishing with Capt. Allan for Oreinus, an idea struck me which I at once carried out. A bucket and a basin were soon brought and one or two cock-fish which were milting, were soon in the bucket. It was sometime however before a half-spent hen-fish was caught. I at once stripped her and fertilized the ova which I told Sodhama to place in the hatching box. He took away the basin with evidently the greatest doubt of any result and it was amusing to see the surprised expression on his face when some days later he came and told me

the ova had all hatched out. He very soon became expert and the work began in earnest the following autumn. Everything continued to be done in the open for two or three years, but, as more ova became available, a hatchery had to be built.

In 1905, when Mr. Pears was the Resident in Kashmir, he and Mrs. Pears came out one day and had lunch with me. Trout of 6″ to 10″ were getting plentiful in the smaller branches of the Arrah River and I asked him to catch one himself, but he was not very skilful with the rod. I caught 8 or 9 fish of 8″ to 10″ while they were with me on small barbless flies, and returned them to the water after showing them to my guests. A letter from Mrs. Pears a few days later was very amusing. She wrote saying she had been speaking to some one in Srinagar of what I had caught and his remark had been that 'Mitchell just catches the same fish over and over again to let you think there are a lot'. While showing the stream to the Pears, I saw a real big trout jump in the old Temple pool and thinking that with so many small ones in the water such a fish was not required, I later asked my brother Henry and some other friends (one of whom, now in London, will remember the occasion) to come out to lunch and see if we could catch it. My brother Henry who was very keen, was off with his rod directly we arrived at Harwan, and when, after a little delay, I arrived at the Temple pool as we called it, the fish, a cock of nearly 6 lbs. was gasping on the bank, having fallen a victim to a small fly spoon. We had him cooked at once and ate the most of him at lunch in the woods. The fame of this fish soon got abroad and a few permits were begged from the Maharajah resulting in some more captures, but it was not until the following year when I was in England and my brother Willie left in charge of the operations at Harwan that fishing began in earnest. When I returned shortly before Lord Minto's visit to Kashmir, general ideas about the success of the enterprise had completely changed, fish up to 9 lbs. having been captured in the Arrah River during my absence. From a financial point of view this made matters easier and simplified arrangements for the spread of trout to other rivers, but it created other difficulties I would gladly have avoided.

The question of a hatchery came on soon after and this was erected on a site no one wanted, just across the road from the ponds. The villagers took no interest in this little plot of land which looked like a bog, but was in point of fact a gravel bed, through which bubbled up the waters of a deep spring, issuing at a temperature of about 45° F. All the land about had been taken up for willow growing, or other village purposes and I had difficulty in getting a spot anywhere near to pitch a tent; so I thought I would put a wooden erection consisting of a couple of rooms and a bath room above this and did so. Kashmir workmen like to pick ova squatting, and the hatching boxes just raised above the floor suited them.

They work always in their bare feet and the spring water at 45° F. running freshly over this floor suited them very much better than dry cement concrete in hard frost. It also kept everything clean and sweet.

From the first the hatchery proved a success and the annual

distribution of ova soon ran into six and approached very nearly to seven figures. The water being fairly alkaline, we used perforated zinc trays instead of glass grills as in the hatching box originally sent out by the Duke of Bedford. Ova, when eyed, were distributed to many streams some of which might have done well had steps been taken early to protect them. The Game Preservation Department under Major Wigram rather specialized on the streams in the upper part of the Kashmir Valley with excellent results. Rearing ponds were established in the gardens at Achibal where unlimited spring water was available. Two lakhs of eyed ova went annually from Harwan to this centre from which yearlings and two-year old trout were easily distributed to the Vaishau and Bringhi and to the other waters of that part which were more especially reserved for State guests.

A demand for trout for State banquets and private dinner parties very early sprang up and this we met from the hatchery ponds at Harwan by selling off the bigger fish of 10 lbs. and over at Rs. 2 per lb. and smaller fish when available at Rs. 3 per lb. By doing so any accumulation of old unproductive fish was prevented and the cost of the work at Harwan was nearly covered annually by these sales and the sales of ova to clubs formed in India following the Kashmir success. It is possible that the price placed on trout at Harwan stimulated the Kashmir poacher in his efforts to meet a local demand at very much lower rates. The upper waters of the Liddar River responded nobly to early efforts to stock them with eyed ova in our 'pahari' ova boxes—now known in England as 'Kashmir boxes' and Col. Faithfull caught and returned to the water no less than 20 trout at Pahlgam one day, fish up to 13″ (about 1 lb. weight) being among the captures. This was the third year after ova had been laid down in these waters, but this success was quickly known and proved fatal. In the winter that followed, when the water was very low, poachers cleared the trout out and I did not attempt to re-stock. Hardly a year goes by without one or two trout falling to rods at Pahlgaum fishing with worm for so called 'snow trout' (*Dipticus maculatus*) but no basket of moment has ever since been made except probably by the poachers in winter. Pahlgaum is much too cold a place at that season for a prosperous game watcher to spend his winter. The lower waters of this river, when stocked and protected by the Game Preservation Department at Thricker, later became one of the best bits of reserved water in Kashmir.

I early turned my attention to the high lakes and with the sanction of Sir Amar Singh, the father of the present Maharajah, camped up through the Datchigam rukh to lakes Mahrsar and Tarsar. The beauty of this rukh (game reserve) consisting of forest grown as nature would have it, grassy slopes ever changing color with the seasonal wild flowers and grey crags stretching up into the snows is wonderful. The animal and bird life is such as one can find nowhere else. My favourite camp half way up was a spot of wild beauty where I could just find room for a little 80 lb. tent. Here I was wakened, the first time I camped there, with the notes of the most delicious Blackbird song I had heard in the East ringing in

my ears. I have many interesting recollections of deer, bears and other fauna of this rukh, but that is another story. I never fished lake Mahrsar, though the last time I was there in a dead calm, I saw a fine fish of about 3 lbs. swim away from the shore. Being in the rukh no one of whom I have heard has had a permit to fish this lake.

For various reasons I turned my attention to the high lakes round Harimukh which rises to over 18,000′. Lake Gungabal, the biggest of these, is about 2 miles long by ½ mile wide and lies 11,700′ above the sea level. It is fed chiefly by glacier water and the flow from two or three small lakes 1,000′ higher. The river from it, after passing over a series of perfect pools and gravels, falls rather sharply 500′ into lake Nunkol, less than half the size of Gungabal from where, after a short run, it becomes torrential till it reaches the Sind River fully 5,000′ lower down. These two high lakes are ideal for trout. The food supply, when trout were first put in, was wonderful, crustaceans especially being unusually plentiful. A red shrimp (about the size of Cyclops) was so numerous that one morning my servants were alarmed by what they thought was a patch of blood, quite a one-eighth of an acre in extent far out on the lake. In less than two hours this disappeared the shrimps going off in single file in every direction, in unbroken lines. Trying to fish in this mass of crustaceans from my collapsible boat in which I went out to examine it, I got touches such as wet fly-fishers must have experienced if they have used their favourite wet fly on a lake when the May fly (greendrake) is up. Small cockles also abounded as autopsies later showed and undescribed flies, including some of an *entirely new family*, showed everywhere. It was not till 1914 that I caught my first fish in Nunkol, a beauty of 3 lbs., and on my return to camp I found my mail with news of Germany's declaration of war on Russia. I sent half the fish to a Major of Gurkhas, who with his wife was camped on the other side of the lake, along with the news and we both started off down the hill as quickly as our transport could be got together. Untouched for some years the trout here multiplied rapidly and other lakes were gradually stocked from the shoals of small ones which soon appeared on the shallows. Lake Vishensar (12,500′) was one of the first stocked in this way. It is the highest lake from which I ever caught trout. I believed at one time that the stock in these high lakes meant, as in Scotland, a permanent source of supply to the river proceeding from them, but I had reason to doubt this when last I visited Gungabal in 1925. The lake is believed to be sacred by the Hindu Pundits and a pilgrimage proceeds there annually in September. An official, who should have known better, took a party up to the lakes when the pilgrims were there and fished in the lake while the bathing was proceeding. The Pundits were furious. There was no protection and ruthless poaching with favourite poisons in the spawning season soon began. Where trout had swarmed in 1922, they were already scarce in the summer of 1925. The best fish I took out of these lakes was 7½ lbs. caught with a small fly such as I always use, but I have no doubt much bigger fish could have been got trolling.

Col. Dew (now Sir Armand) was much interested in the trout

work at Harwan and suggested finding money to cover the expense of sending ova and a skilled man to Gilgit, where he commanded and was satisfied there were suitable streams. The journey of 200 miles on a bridle path, crossing passes of 11,600′ and 14,500′ in mid-winter was an exceedingly difficult one and the first attempt failed, through the ova getting frozen. A later attempt was quite successful and the Harwan expert remained at Gilgit for some months till the fry stage had been reached. Col. Dew had then left, but the late Col. Macpherson, who succeeded him, was also keenly interested and the officers of the Agency have since had good sport with trout there.

After 1909, I was very little in Kashmir during the winter and Mr. Hugh Blunt who was with us in the Carpet Industry, took my place when I was away. He was very keen and made some useful additions and improvements at Harwan where Spring and Autumn of the years that followed were my chief times for visits.

The introduction of fauna into a foreign country must always be attended with risks of which it is easier to judge after the event; but looking back on 30 years I can see no serious harm directly attributable to the introduction of trout into Kashmir. That other fish are now scarce is more due to the great increase in the number of licensed fishermen who have gained by the rise in prices of fish. They made great scoops when the Woolar lake was lowered and they got access to the winter refuges of the native fish. The scarcity of these (especially the Oreinus) is now a loss to the country as they undoubtedly kept the rivers free of Algae growth and being spring spawners (when rivers are flooded by melting snow) if reasonably protected they were not so liable to almost total extinction as are trout by the barbarous poisoning methods which Indian poachers adopt when rivers are reduced by frost to mere trickles. Those who control the country will have to look at both sides of the picture in the future policy they have to pursue and I can only wish them every success.

Note on Native Fish of Kashmir.

The Kashmir fish referred to generally in Col. Godfrey's letter as 'hill barbels' are in the rivers.

1. The Cheroo—*Schizothorax esocinus.*
2. The Choosh—*Schizothorax intermedius.*
3. The Khont—*Oreinus sinuatas.*
4. The Snow Trout—*Dypticus maculatus.*
5. The Cat fish 'Anyur'—*Exostoma stoliczkæ.*
6. The Horned loach—'Ramgrun' *Botia geto.*
7. The Loach 'Tilgrun'—*Nemachilus stoliczkæ* or *marmorata.*
8. The Kashmir Grayling 'Ruppert' *Labeo dyochilus.*
9. The Mahseer—*Barbus tor*—migratory, coming up to spawn only.

A small lake fish *Cirrhina latia* which spawns on the weeds is also very plentiful and was much used for feeding trout.

Day described other species, but for practical purposes those I have enumerated above are all one comes in contact with.

They are all spring spawners and I regret to say that they were largely fished for in the past when they were spawning. The bigger fish then came up from the deep lakes and were easily caught. Cheroo hen-fish up to 20 or even 25 lbs., with ova actually running out of them when brought on board the fisherman's boat, were at times caught at Ganderbal where the Sind River leaves the hills—not unusually with what is known in Scotland as the 'London fly'. The cock-fish are always much smaller. These are caught often by fishers for Mahseer in autumn near the Woolar lake and then, when they are in condition, would give good sport on lighter tackle than that used for 40 lb. Mahseer. The Choosh don't run as big as the Cheroo and are by some anglers mistaken for the Khont which is much more of a river fish. This fish takes its name of 'Sinuatus' from its habit of twisting under water when sucking alga and moss off the stones with its thick sucking lips. Thousands of Khont when in their best condition in late autumn used to enter the big springs of the Arrah and Achabal Rivers and remain during winter in the underground streams—the source of these springs. They are, as far as I have seen, really useful in trout water, and it was much against my wish that efforts were made to exterminate them in such streams. A gentleman from New Zealand visited Kashmir in the early days and seeing the Oreinus lying in black masses at the bottom of some of the pools in the Arrah River, expressed disbelief in the success of trout there with such quantities of native fish. I laughed at him and told him I knew the relative powers of both fish and that I had no doubt on the subject. I have reason to think however that his expressed opinion added much to the disbelief in trout prospects which then existed in the country and did harm later in causing destruction of Oreinus I would have saved.

In some of my later reports I expressed myself strongly on the subject as the disappearance of Sinuatus synchronised with a great increase of alga and other deleterious matter as well as with a distinct decrease in the average size of trout. Like Mahseer these and the Schizothorax have their teeth in their throats.

The Exostoma are most interesting fish though very ugly. Poor swimmers, they yet are the only fish I have found who can make their way to the highest lakes by using their pectoral fins to climb over the stony sides of streams. They are fond of worms and can exist for many hours out of water. They are said to carry their young in their mouths and I once did find a very small living fish so placed.

The common loaches are very like those in English waters, but the Ramgrun is very different; a lake fish chiefly, he enters the streams to spawn and like the mango fish of Bengal is most appreciated when full of ova. The horn or spike by the gill is very sharp and should be avoided when holding the fish. *Labeo dvocheilus* has scales like a grayling and is one of the best eating fishes of Kashmir and scarce in consequence. Like the others he is however very boney.

THE HISTORY AND PROGRESS OF THE ZOOLOGICAL SURVEY OF INDIA

PART III

(*Continued from page 219 of this volume*)

CRUSTACEA SECTION

By B. CHOPRA, D.SC., F.L.S.

The study of Crustacea has been carried on continuously in the Indian Museum for well over fifty years and indeed has become a tradition of the institution. The galaxy of brilliant workers, such as Wood-Mason, Alcock, Annandale and Kemp, who made a critical study of the different classes of this group, have made the Indian Museum famous as a centre of research on Indian Carcinology. Before the foundation of the Indian Museum some work on Crustacea was being done and collections of this group were being accumulated in the museum of the Asiatic Society of Bengal, which, as is well known, formed the nucleus around which the present Imperial Museum has been built. Brian Hodgson, whose researches on the fauna of Nepal have become a classic of Natural History, was the first to take up a study of Zoology seriously in this country, but Edward Blyth was the real founder of the Zoological Section of the Indian Museum. He was appointed Curator of the museum of the Asiatic Society of Bengal in 1841, and immediately set about collecting and describing the vertebrate fauna of the Indian Empire. To the invertebrates he paid comparatively little attention, but it is interesting to note that there are still in the Indian Museum specimens of freshwater prawns, which he had named, evidently with the intention of describing them later.

With James Wood-Mason really started the serious study of the Indian Crustacea. He joined the Indian Museum as Assistant Curator in 1869 and later became its second Superintendent, succeeding John Anderson in 1887. Soon after joining the Museum he commenced a survey of the Indian marine and freshwater Crustacea that has proved of the greatest benefit to Indian Carcinology in so far as it constituted the beginning of a long and brilliant series of papers and monographs dealing with this group. Unfortunately his published work does not represent a fraction of his accumulated knowledge, principally because he had an almost fastidious objection to publishing anything that was not exhaustively complete. The very valuable and copious notes on the Crabs and the Stomatopoda that he left behind him, proved of the very greatest help to his successors, Col. Alcock and Dr. Kemp, in their work. He also helped very considerably in enriching the collections of the Indian Museum, for soon after joining his post

he started collecting and studying the Indian marine and fresh-water Crustacea. His energies were not confined to the zeal with which he persuaded friends and correspondents in all parts of the Indian Empire to contribute specimens of crabs, prawns and Stomatopod Crustacea, for he made the fullest possible use of the limited opportunities he had for field work, not only as regards the groups—Crustacea and Insecta—in which he took a special interest, but also in respect of many others. To Wood-Mason also belongs the honour of being the first to carry out deep-sea biological investigations in the Indian Ocean, when in 1872 he was deputed by the Trustees of the Indian Museum to proceed to the Andaman Islands and make a collection of the marine fauna of that area.

Alcock, who succeeded Wood-Mason as Superintendent in 1893, made it his aim to work, as far as it is possible for one man to do so, the fauna of the deeper parts of the Indian seas. His series of 'Catalogues' of the Indian Crustacea and his memoirs on the Crustacea collected by the R.I.M.S.S. *Investigator* are too well known to all Carcinologists to require a special mention here; while his 'Materials for a Carcinological Fauna of India' published in six parts in the *Journal of the Asiatic Society of Bengal* (1895-1900) is, as is well known, indispensible to all workers on Indian, or in fact Indo-Pacific crabs. The collections also owe a great deal to his efforts both during his tenure of office as Superintendent of the Indian Museum and, before that, as Surgeon-Naturalist on board the R.I.M.S.S. *Investigator*.

The interest that Annandale, who joined the Museum as Assistant Superintendent in 1904, succeeded Alcock as the Superintendent in 1907 and later became the first Director of the Zoological Survey of India in 1916, took in the study of the Indian Crustacea was of a more limited nature than that of his two immediate predecessors, Wood-Mason and Alcock. He was specially interested in the Cirripedia, or the barnacles, and published several valuable papers on these interesting animals in the *Records of the Indian Museum* and other scientific journals. He was a very keen field naturalist, and during his term of office both as Superintendent of the Museum and as Director of the Zoological Survey of India the officers under him were, as a result of his continued representations, given increased facilities for extensive touring and field work. Dr. Annandale personally was keenly interested in the fauna of fresh- and brackish-water lakes and the Museum has, therefore, come to possess a very fine collection of Crustacea, as also of other groups of animals, from most of the important lakes of the Indian Empire, and of other parts of Asia.

Dr. S. W. Kemp, Senior Assistant Superintendent in the Natural History Section of the Museum and later Superintendent of the Zoological Survey of India, was a Carcinologist first and foremost, and his contributions to the study of Indian Crustacea are among the most important work done on this group within recent years. His account of the Stomatopoda of the Indo-Pacific region is the most comprehensive and authoritative treatise on this group of

Crustaceans, while his series of 'Notes on the Decapoda Crustacea of the Indian Museum', of which he published twenty-four parts in the *Records of the Indian Museum,* contains, besides a great deal of other useful information, complete systematic revisions of several genera and families. He also wrote a large number of papers describing the Crustacea collected by the different survey parties and officers of the Zoological Survey of India and other expeditions. His retirement from India in 1925, on his appointment to the Research Directorship of the 'Discovery' Expedition, has been a very great loss to Indian Carcinology and in fact to Indian Zoology in general.

Col. R. B. Seymour Sewell during his tenure of office as Surgeon-Naturalist on board the R.I.M.S.S. *Investigator,* as also since his appointment as Director, Zoological Survey of India, has been devoting a great deal of his time to the study of Crustacea, and is recognized as an authority on the Indian marine Copepoda. At the present time he has in the course of preparation a comprehensive monograph dealing with these animals, which will be published in the *Memoirs of the Indian Museum.*

Since my joining the Zoological Survey of India I have also been giving most of my time to the study of Crustacea and have published a monographic account of certain parasitic Isopoda. Besides continuing my researches on these animals I am getting together material for a complete systematic revision of the Indian freshwater crabs.

As a result of all the fine work on the Crustacea that has been carried on in the Museum for well over fifty years, the Zoological Survey of India possesses at the present time very rich collections of these animals. These collections have been accumulated from various sources, but most of the material has been collected by the officers of the Museum and the Zoological Survey of India and by the successive Surgeon-Naturalists on board the R.I.M.S.S. *Investigator.* The Zoological collections of the Asiatic Society of Bengal were mainly of vertebrate animals and contained comparatively few Crustacea.

The various military and political expeditions, on which zoological specimens were obtained, have enriched very considerably the collections of the Indian Museum, but interesting specimens of Crustacea and other invertebrates were only rarely brought back by them. Of the expeditions that went to the north-western parts of India, the Pamir Boundary Commission (1896) must be especially mentioned in this connection; Lt.-Col. (then Captain) A. Alcock was attached to this Commission as Surgeon-Naturalist and brought back a very interesting collection from the Russian frontier on the Pamirs. Of the expeditions that went to the eastern parts of the Himalayas, the Dafla Expedition (1874, 1875) to which Godwin-Austin was attached as a Major in the R.E., and the Abor Expedition (1911,1912), on which permission was given for the first time for a zoologist from the Museum—Dr. S. W. Kemp—to accompany the force in the capacity of a naturalist, must be referred to specially. The collections, including those of Crustacea, brought back by Dr. Kemp were very extensive and of an exceptional

interest, and have been described in a special volume (vol. viii) of the *Records of the Indian Museum.*

Another very important source from which collections have been coming for over fifty years past is the R.I.M.S.S. *Investigator* and the Surgeon-Naturalists that have successively worked on board this ship. Though most of the Surgeon-Naturalists have helped in the accumulation of valuable collections, the names of Alcock and Sewell must be specially mentioned as having enriched the Crustacea collections of the Museum particularly.

The officers of the Museum and later of the Zoological Survey of India have always considered field work an important part of their duties. Dr. J. Anderson's work in the field is an illustration of this point. He was the first Superintendent of the Museum and the prominent part he took as a Naturalist on the two expeditions that passed through Burma to Western China, the first in 1868 and the second in 1875, is very well known. Shortly before leaving India he also undertook on his own account an expedition to the Mergui Archipelago, the Zoological results of which were fully described in two special volumes of the *Journal of the Linnean Society* (vols. xxi and xxii); the Crustacea collections were mainly worked out by the famous Dutch Carcinologist, Dr. J. G. de Man. In the same way, as has already been mentioned, Wood-Mason, Alcock and Annandale did a great deal of field work and enriched very considerably the Museum collections. The same policy of extensive field work has been continued in comparatively recent years and is being pursued at the present time.

Though the Crustacea collections under the charge of the Zoological Survey of India are rich in a general way, there are certain groups that are better represented than the others. As has already been referred to, Alcock took a great interest in the study of crabs, with the result that the Museum now possesses a very fine collection of these animals—probably the best available in any museum in the world so far as the Indian region is concerned. In the same way, Kemp, who made a special study of the Stomatopoda, was instrumental in bringing together an excellent collection of these animals. A part of this collection, however, had already been accumulated by Kemp's predecessors. In the same way, owing to Kemp's personal interest in the group, the Museum possesses vast collections, in most cases authentically named and properly arranged, of the different kinds of prawns and shrimps. Similarly the very valuable collection of the Cirripedia that we possess is due to Annandale's interest in these animals. Of the Crustacea collections brought together and studied by the officers of the Museum and the Survey, as also by other specialists in India and abroad, some of the important ones may be enumerated as follows :—

Lower Crustacea.—named by R. Gurney and E. von Daday.

Cirripedia.—named by N. Annandale.

Copepoda.—named by R. B. Seymour Sewell.

Isopoda (terrestrial).—named by T. R. R. Stebbing and W. E. Collinge.

Isopoda (Epicaridea).—named by B. N. Chopra.

Amphipoda.—named by Chas. Chilton and W. M. Tattersall.
Mysidacea.—named by W. M. Tattersall.
Decapoda (Macrura) named by J. G. de Man and S. W. Kemp.
Decapoda (Brachyura).— named by J. G. de Man and A. W. Alcock.
Stomatopoda.—named by J. Wood-Mason and S. W. Kemp.

As a Survey department in charge of the Zoological Section of the Museum it is our aim to get together as representative a collection of the Indian fauna as we can, and it is in this line that outside workers and naturalists can help us. With so few officers in the Zoological Survey of India it is natural that some parts of the country may not be thoroughly surveyed or even receive any attention at all for several years to come. The members of the Bombay Natural History Society, many of whom are keen naturalists, can send us, with very little trouble, specimens, some of which at any rate are sure to prove of interest. Sometimes specimens that appear very common turn out to be of great scientific value. In the case of Crustacea, especially the larger forms like crabs and prawns, all that need be done is to preserve the specimens in strong spirit, with a label recording the exact locality, date of capture, notes on their natural colour, habits and any other points that may strike the collector as of interest.

ENTOMOLOGICAL SECTION

By Hem Singh Pruthi, M.Sc., Ph.D. (Cantab.), F.Z.S. (Paris), etc.

The collecting of Insects and their systematic classification has always formed part of the general zoological work carried on by the Natural History Section of the Indian Museum, but the history of Entomology in this institution may really be said to have commenced in the year 1885 when the Trustees of the Indian Museum, realizing the economic importance of insects, decided that the study of insect crop-pests should be specially taken up by the Museum staff. Mr. E. C. Cotes, then Deputy Superintendent of the Museum, was given this work and he published a series of papers on economic entomology in *Indian Museum Notes,* a periodical specially started for this purpose. Besides Mr. Cotes, Mr. Wood-Mason, the Superintendent, and several other distinguished workers, like Bingham, Buckton, Atkinson, etc., contributed valuable papers to this periodical of which five complete volumes were published between the years 1888 and 1901. By the latter year the importance of entomology having come into still greater prominence, the Government of India added a post of Entomologist to the Museum staff. Mr. L. de Niceville was the first incumbent of this appointment, but unfortunately he had hardly worked for a year when he died of malaria contracted in the Darjeeling Terai where he had gone to study the mosquito-blight. Mr. E. P. Stebbing, who was officiating as the Superintendent at the time, continued the entomological work and published an additional part of the *Indian Museum Notes*. But soon after Mr. de Niceville's death it was decided to transfer the post of the Entomologist to the Government of India from the Indian Museum to the newly-started

Agricultural Research Institute at Pusa, and thenceforward the Indian Museum was expected to restrict its entomological activities to purely systematic work. Though both the Government of India and the Imperial Department of Agriculture recognized that no economic work would be of much value unless based on sound systematic work, no officer was appointed in the Indian Museum for carrying on this line of research. This state of affairs continued for about nine years, viz. up to 1910, when an increase in the staff of the Museum was sanctioned and Dr. F. H. Gravely was appointed as the officer in charge of the Entomological section. Dr. Gravely left Calcutta early in 1920 to take up the duties of the Superintendent of the Madras Museum and from then on until 1923 the entomological section was again without a special officer. In July, 1923, however, the Government of India sanctioned the appointment of an entomologist and Dr. B. N. Chopra was appointed. I relieved Dr. Chopra in 1925, but had only worked for about two months when I left for Europe, having been elected to a Research Fellowship of the International Education Board. I returned to Calcutta in November, 1926, and since that date have held charge of the Entomological section.

In the introductory part of this article Col. R. B. Seymour Sewell has referred to the valuable collections that the Asiatic Society of Bengal presented to the Indian Museum when it was founded in the year 1875. These collections included among other groups a large number of insect specimens. This collection, though by no means very rich, served as a nucleus round which the successive officers of the Museum have built up a really fine collection of Indian insects. In addition to the collections made by the officers, the Museum possesses the following important collections made by private individuals which were purchased or secured as donations :—

1. L. de Niceville's collection of Lepidoptera.
2. Stoliczka's Zoological collections made during the second Yarkand Expedition.
3. Das's collection of the Aphids of Lahore.
4. E. E. Green's collection of Lepidoptera.
5. G. C. Dudgeon's collection of Lepidoptera and Hymenoptera.
6. Van de Poll's collection of Coleoptera (Passalidæ).
7. J. Gregory's collection of Odonata from Yunnan.
8. Lord Carmichael's collection of Insecta and Arachnida from the Eastern Himalayas.
9. Otto Moller's collection of Lepidoptera (Heterocera).
10. Col. A. H. McMahon's (Seistan Boundary Commission) collection of Insecta from Seistan.

The insect collections of the Indian Museum have been named by the most eminent authorities available in India and abroad. The insects consisting of over twenty orders and a couple of hundred families, constitute a very large group, and the number of specialists who have worked out our collections is very large. In the following list I mention a few of the most important ones :—

Orthoptera—J. Wood-Mason, J. L. Hancock, M. Burr, L. Chopard, etc.

Odonata—F. F. Laidlaw, F. C. Fraser.

Rhynchota—E. E. Green, van der Goot, W. L. Distant, B. Das.

Lepidoptera—E. Meyrick, G. F. Hampson, E. C. Cotes and Swinhoe, B. Preston Clark, W. H. Evans, L. de Niceville.

Coleoptera—S. Schenkling, W. Horn, F. H. Gravely, G. J. Arrow, S. Maulik, H. E. Andrewes.

Diptera—E. Brunetti, J. J. Kieffer, S. R. Christophers, F. W. Edwards, P. Alexander, M. Bezzi, C. H. Townsend, T. H. Becker, W. S. Patton.

Hymenoptera—C. T. Bingham, S. A. Rohwer, C. Morley.

Arachnida—F. H. Gravely, C. F. Roewer, C. H. Simon, K. Kraeplin.

Myriapoda—R. I. Pocock, F. Silvestri.

The insect collections of the Zoological Survey of India are very important and valuable. They are consulted not only by Indian workers, but by entomologists all over the world. Since joining my appointment I have been paying a considerable amount of attention to the care of these collections. In view of the climatic conditions in this country, which are highly conducive to the development of moulds, etc., the collections are periodically examined, cleaned and tended by the entomological staff. The standard store boxes introduced into India by the late Dr. H. M. Lefroy having proved unsatisfactory, our collections are being transferred into 'twenty-drawer' cabinets, rearranged and labelled according to the most recent systems of classification and nomenclature.

Though the insect collection of the Museum is one of the richest in the world so far as the Indian fauna goes, it has yet many *lacunae*. To fill up the gaps we are endeavouring to get fresh collections from all parts of India. This we mostly do by going into the field ourselves, but few as we are, we badly need the assistance of amateurs like most members of the Bombay Natural History Society who can send us specimens from different parts.

Another duty of the officers of the Zoological Survey of India is to undertake faunistic studies on different groups of animals. It is very gratifying to record that the various successive officers in the insect section have made valuable contributions to Indian Entomology, both pure and applied. Mr. Cotes laid the foundation of economic entomology in this country and the various volumes of the *Indian Museum Notes,* which contain a large number of papers by him and for the editing of most of which he was responsible, are indispensable works of reference in the various Agricultural Colleges and Research Institutes in India. Wood-Mason's classical works on the Mantidae and Phasmidae are well known to entomologists both in this country and abroad; these papers, which were published over forty years ago, are still the best works on the subject. Dr. Gravely did pioneer work on Indian Spiders and on the Passalid and Lucanid beetles, while Mr. Brunetti, who was mostly unofficially, but for a time officially, connected with the Indian Museum, did a vast amount of work on Diptera. Dr. B. N. Chopra started work on May-flies, but had finished only two families when he was transferred to the Crustacea section. Before closing

this list it is also necessary to mention the work of Mr. C. A. Paiva, an assistant in the Insect room. He, besides contributing a large number of papers on Hemiptera, completed an important survey of the mosquitoes of Calcutta in 1912; this latter work has served as a nucleus for numerous similar surveys that have been undertaken in recent years.

Systematic entomology is rapidly passing, if it has not already passed the stage when it consisted merely of collecting and naming specimens. Efforts are now made to study the conditions under which the different insects live with a view to explaining why particular species are only met with in particular areas and nowhere else. For instance, in the case of aquatic animals careful observations are taken of the temperature, gaseous and salt contents and hydrogen-ion concentration (acidity) of the water in which the animals are found. These studies, which are collectively included under Ecology, are of special help in solving many interesting problems of animal distribution. While the marine fauna of India has been extensively studied from this point of view by Lt.-Col. R. B. Seymour Sewell, the freshwater forms in this country have not been studied along these lines. I, therefore, on joining my appointment in the Zoological Survey of India in 1925 took up this line of research with special reference to Insects.

The study of the ecology of aquatic insects is in its infancy in both India and other parts of the world. The few papers that exist on the subject are mostly concerned with mosquitoes. But in view of the fact that the respiration of mosquito larvae is almost independent of the gases dissolved in water, a very important factor in aquatic biology, the conclusions derived from the work on mosquito larvae do not apply to true aquatic insects. Hence I studied the specific effect of hydrogen-ion concentration, carbon dioxide and oxygen contents of water on the common May-fly larvae. As a result of a long series of experiments I reached conclusions which, as expected, were quite different from those resulting from the study of mosquito larvae alone. Some of my conclusions have recently been confirmed by workers in the United States of America. Incidentally, my experiments on May-fly larvae showed that the prevalent views with regard to the death of fishes in polluted waters required modification. I tested my hypothesis by numerous experiments on fishes and obtained some very interesting results.

Since last year I have been engaged on a study of the influence of different temperatures, and hydrogen-ion concentration of water on mosquito larvae. Many observations with regard to these factors, especially the former, are on record and these larvae have been observed in waters having greatly varying temperature and acidity. But hardly any investigator has gone into the important question whether the different temperatures and hydrogen-ion concentration at which the larvae have been found to occur are the optimum for their successfully developing into adult mosquitoes. My work on these lines, though yet incomplete, shows that mosquito larvae, although they can live in wide ranges of the abovenamed factors, can become pupae and adults only under very much

limited conditions. This conclusion suggests that before incurring the heavy expense of killing mosquito larvae in a particular pool, it will be worth while ascertaining whether the condition of the water in the pool will allow the larvae to become adults and so to transmit disease.

The second line of my research is the taxonomy of the Jassid bugs of India. These bugs are of great economic importance, since most of them are serious pests of valuable crops, gardens and orchards. The taxonomy of the Jassidae of India as well as the rest of the world is in a great muddle. Distant in his Rhynchota volumes of the *Fauna of British India* series monographed the family Jassidae, and about two-thirds of the genera found in India have been founded by him. It appears, however, that this work of Distant was not so carefully done as his earlier works. In fact, some great authorities on this group, like the late Dr. C. F. Baker, have declared that Distant's work instead of clearing our knowledge of the forms, has thrown the Oriental Jassidae into complete confusion. I have, therefore, thought it desirable that this important group of bugs should be revised.

Since the last three years Mr. M. Sharif, a temporary Assistant Superintendent, Zoological Survey of India, is working on Ticks and Fleas of India.

We will not be doing good service to science if we were not to freely place all the facilities that the section can afford at the disposal of other workers. We name or arrange to get named specimens received from workers engaged on research in different branches of Agriculture, Veterinary Science, Public Health, etc., and from those engaged in research in pure science in the laboratories of various Indian Universities. We supply, as far as possible, sets of the common Indian insects to recognized educational institutions on request, and students from several Indian universities are encouraged to come and work in our laboratories.

FISH SECTION

By Sunder Lal Hora, D.Sc. (Punjab), D.Sc. (Edin.), F.R.S.E., F.L.S., F.Z.S.

I need not go into details about the interest and economic importance of fishes and how intimately they touch the life of man all over the world. Linneaus once said, 'So great is the importance of fish to the enjoyment of the rich and the necessities of the poor, that man might with less inconvenience, give up the whole class of birds and many of the mammalia than be deprived of the finny tribes'. Considerable interest is being shown in this branch of zoology in India at the present time either in connection with the fisheries or in reference to the influence of fish in the prevention of the spread of certain diseases such as malaria. Leaving these general considerations aside, I propose giving here a short history of the fish collections in the Indian Museum with a view to directing the attention of the members of the Bombay Natural History

Society to the resources that are available for ichthyological research in India and indicating at the same time how these can be augmented.

A series of about 4,000 specimens handed over by the Asiatic Society of Bengal to the Indian Museum in 1875 formed the nucleus of the present-day extensive collections, both named and unnamed, of the Zoological Survey of India. A large number of the Society's specimens consisted of presentations from Day, while a considerable proportion had been named and described by Blyth, and as a result we possess a fair number of typical specimens of the species described by these eminent ichthyologists. This is extremely fortunate as these and other typical specimens have made it possible for the Indian Museum to be recognized as a centre of ichthyological research in the East. The study of fish, especially of the freshwater forms, is a difficult problem as since Day's time our piscine fauna has not been adequately monographed. In the neighbouring countries, however, these animals have received considerable attention and this has rendered the definition of some of our genera and species a matter of considerable importance and difficulty. It is very easy to consider two imperfectly described fishes from widely separated areas identical, as there is nothing in the published descriptions to separate them. The late Dr. N. Annandale, during his extensive travels in the Far East, made large collections of fishes and presented these to the Indian Museum. These have been described by specialists and are of immense use in clearing up difficult questions of synomymy of the type referred to above. Mention may also be made here of a very large collection from Siam which Dr. Malcolm A. Smith has presented to the Zoological Survey. As a result of the Zoological collections made during the Military and Political Expeditions to the adjoining countries in the north of India the Indian Museum collections comprise fairly representative collections of fish from Afghanistan, Seistan, Tibet, Yarkand, etc. These collections render it possible for a worker to go into details about the question of the evolution of Indian fish fauna. Moreover, the frequent requests that are received for working out collections of fishes from the neighbouring countries bear testimony to the value of the extra-Indian material that we possess. Any additions to this collection are of very great help and will be gratefully accepted.

Owing to the continued activities of the Surgeon-Naturalists on the R.I.M.S.S. *Investigator* the Indian Museum possesses a very large collection of Marine fishes. The deep-sea fishes have been catalogued by Alcock. Collections made by the Bengal Fisheries trawler *The Golden Crown* were also deposited in the Indian Museum, and Annandale and Jenkins have dealt with a part of this collection in a series of extremely valuable monographs.

A very large proportion of the recent collections is due to the activities of the members of the Zoological Survey of India, who have made extensive collections during their tours all over India and Burma. In recent years we have surveyed a number of freshwater lakes and have discovered forms of unusual interest. In no small measure we are indebted to a number of amateur naturalists who

have sent us collections and much valuable information has been collected in this way. The results of several of these collections were published by Dr. B. L. Chaudhuri in a series of papers in the *Records of the Indian Museum.*

A good reference collection forms the basis of sound taxonomic work and in this connection I would request the authors working on Indian Fish to present specimens from the type-series for the collections in the Indian Museum. The climate of Calcutta is considered by some to be very adverse to the preservation of zoological specimens, and on this account a certain number of workers wish to deposit their types in European museums. So far as the preservation of fish is concerned it may be indicated that many of Blyth's, Day's and even earlier specimens still exist in good condition in our collections, and there is, therefore, no question of the climate of Calcutta being in any way specially injurious to fish collections. We are also endeavouring to obtain authentically named specimens of the species described from India, but it is very difficult in reference to the species of older authors. The *lacunæ* in our series of types can, however, be filled by obtaining series of toptypes and it is in this connection that the members of the Bombay Natural History Society can be of very great help to us. Students of Indian ichthyology are no doubt aware that the two pioneer and outstanding works on Indian Fish are Patrick Russel's *Fishes of Vizagapatam* (1803) and Francis Buchanan's (afterwards Hamilton) *An Account of the Fishes Found in the River Ganges and its branches* (1822). Both these workers described and figured various species, but they did not make any collections. In the absence of any material some of their species have been grossly misinterpreted and the only way to clear the controversy regarding their species is to obtain examples from the type-localities. This material will be extremely useful for the purposes of taxonomic research. In the case of *Gangetic Fishes* it is still further unfortunate that the author was not allowed to utilize most of his material, drawings and notes, in the preparation of his finally printed work. Whereas Russell described the fish-fauna of one place—Vizagapatam—and most of his species can be collected and verified in a short time, Buchanan worked in a much wider field. His material was collected mostly during the period when he was engaged in a Statistical Survey of Bengal. His species came from Dinajpur, Rangpur, Purniah, Bhagalpur, Patna, Shahabad, Gorakhpur, Calcutta etc., and it will be extremely useful if collections can be obtained from these places. The local names of fishes, notes on their bionomics and habitats are also essential as these by comparison with Buchanan's notes will, in most cases, enable us to identify the species with certainty.

Recently I have read several short popular articles dealing with Indian fish. Extremely valuable information is sometimes contained in these notes, but the authors do not care to deposit their material in any recognized institution. In the absence of authentic material the scientific value of their observations is considerably discounted. A reference collection needs continuous additions to replace bad specimens or those used up for morphological investiga-

tions. The members of the Bombay Natural History Society can render great service by sending to the Indian Museum a representative collection from their respective stations. Most of the fish inhabiting the plains of India are known to science but little information is available about their bionomics and life-histories. Any piece of information on these points, either collected from personal observations or gathered from the local people, is likely to be of great value and should be placed on record. For example in this country the freshwater fauna is subject to considerable changes in different areas. The animal life is adjusted to these conditions by a series of marvellous adaptations the study of which is both interesting and necessary. The supposed rains of fishes, the stories connected with the air-breathing fishes such as *Anabas, Clarias, Ophicephalus, Amphipnous* and *Saccobranchus* are well worth investigating scientifically. The ways and means by which the fish have adapted themselves to a life in the fiercest currents of our torrents is a subject full of fascination and delight and is the one in the study of which I can help enthusiastic naturalists to some extent.

As pointed out above collections from all over India, Burma, Ceylon and adjoining countries are welcome, but interesting material containing new forms will mostly be found in the hills. Special attention should be paid to the smaller forms which are liable to be overlooked. The fish fauna of Sindh, the Western Ghats, the Eastern Ghats, Burma and of the Assam Hill Tracts, is very little known and much valuable material can be collected in these parts.

Specimens when caught should be killed in weak formalin, 4 to 5 per cent, and kept in this reagent overnight. The fishes in this solution die with their fins expanded and are well fixed; they can then be preserved in alcohol.

It may be mentioned in passing that the Secretary of State for India has recently sanctioned a revision of Day's fish volumes in the *Fauna of British India* series to be undertaken by me. It is my intention to render the new volumes not only useful to Museum workers but also to the field naturalists by including extensive biological notes on the different kinds of fish. Older zoology treated almost exclusively of structure; nowadays we take into account, besides anatomy, function, habits, physiology and ecology. We must consider animals not only as Museum specimens, but as living individuals definitely related to a certain natural environment, —an environment in which certain physical conditions (of temperature, moisture, light and darkness, etc.), which provides them with shelter and with certain kinds of animal or vegetable food; an environment in which their young, their fellows of the same species, their friends and enemies of other species, form a part. It is needless to say that in undertaking a work of this magnitude I rely greatly on the help of all lovers of field zoology, and shall be greatly obliged if the members of the Bombay Natural History Society can help me with collections and notes on the habits of fishes, the economic importance of the various species, etc.

ANTHROPOLOGICAL SECTION

BY *B. S.* GUHA, M.A., PH.D.

The Anthropological Section of the Zoological Survey of India consists of a large collection of ethnographical objects most of which are shown in the Ethnological Gallery, and osteological remains not yet exhibited to the public. The former had its nucleus in the objects presented by the Asiatic Society. Since the beginning of its foundation, the Asiatic Society, under the inspiring guidance of Sir William Jones, had been collecting various objects and implements illustrative of the life and habits of the different races and tribes of India. A catalogue of the objects was prepared by Dr. Rajendra Lal Mitra in 1849, and later revised in 1868. The revised catalogue gives the total number of objects as 1,859.[1] As a result of the foundation of the Indian Museum the ethnological collections in the Museum of the Asiatic Society together with others were transferred to the Indian Museum in the year 1875. From this time onwards new additions were made, of which the most important was the collection of Indian musical instruments presented by Raja Sourindra Mohan Tagore. In the year 1885-86, however, the ethnological collections were handed over to the Bengal Economic Museum and on the 1st of April 1887, the combined ethnological and industrial collections of the Government of Bengal came into the possession of the Trustees of the Indian Museum.

On the completion of the new wing of the Museum Building in 1891, the ethnological collections which were hitherto kept in five small rooms in the south of the Museum, were transferred to the Ethnological Gallery which was formally opened to the public on 1st January, 1893. The total number of objects at this time was 6,517. In 1911 the ethnological collections were transferred again from the Industrial to the Natural History Section. The valuable osteological collection made by Dr. John Anderson had remained all along under the direct care of the Superintendent. After the transference of the ethnological objects to the Natural History Section, the two collections were reunited and the entire Natural History Section became officially known as the Zoological and Anthropological Section. There were two important accessions at this time, namely: (1) The Abor collection made by Dr. Kemp and Dr. Coggin-Brown from the Abor Expedition of 1911-12, and (2) the gift of an additional set of Indian and Japanese musical instruments from Raja Sourindra Mohan Tagore, which made our collection of Indian musical instruments one of the finest and most complete of its kind in the world.

In 1916 the Zoological Survey of India was instituted and the Anthropological Section, which was incorporated in it, ceased to bear a separate name. But as there was no special officer in charge of the anthropological collections, they were left under the direct care and supervision of the Director of the Zoological Survey who fortunately happened to have the additional qualifications of a trained anthropologist and took great interest in the collections.

[1] The Centenary Volume of the Indian Museum, p. 22. Calcutta, 1914.

It was through his efforts that the services of Dr. G. H. Meerworth of the Imperial Ethnographical Museum of Petrograd in 1917 and of Mr. Johan van Manen in 1922 were temporarily secured for the department. Dr. Meerworth prepared illustrated Guide books to our collections of musical instruments[1] and the Aboriginal Tribes of the Andamans, Nicobars and Assam.[2] Mr. van Manen went through the Tibetan specimens and rearranged them.

In spite, however, of the temporary services of the above scholars and the interest taken by Dr. Annandale, the Director, it was felt that not only no further progress could be made in the collections of the Anthropological Section but a systematic classification and organized display of even the existing objects was not possible until a whole-time officer was placed in charge of them. In the past, the Anthropological Section had an extremely chequered career passing from one department to the other, as a result of which not only had the objects not been properly labelled but in some cases even the records were lost, e.g. in the case of the large series of human pelves[3] in our osteological collection. The importance of a well-equipped Anthropological Section for scientific research, as well as its great value to the State, was urged upon the Government by Dr. John Anderson, F.R.S., in his Annual Report of the Museum as early as 1881-82. Dr. Anderson, writing on the neglect of anthropological study in India, deplored the fact that 'the museums of the leading capitals of Europe could boast of a more complete collection of Ethnology of India than the Calcutta Museum itself'.[4] The special importance of Anthropological research in this country was brought to the notice of the Government by the Council of the Royal Anthropological Institute in their letter to the Secretary of State for India, dated the 18th of April 1913, and in 1914 the Trustees of the Indian Museum recommended to the Government for the appointment of a trained Anthropologist to take charge of the collections of the Indian Museum. Due to the war the matter did not proceed any further, until 1920, when Dr. Annandale as Secretary to the Trustees again urged the importance of the appointment of an Anthropologist. The Government gave its approval, but acute financial stringency prevented it from giving practical effect to Dr. Annandale's proposals.

After his appointment as Director of the Zoological Survey in 1925, in succession to Dr. Annandale, and like his predecessor a student of Anthropology, the matter was again taken up by Lt.-Col. R. B. Seymour Sewell, and with the support of the Trustees he approached the Government for the immediate appointment of an Anthropologist. This time the Government sanctioned an Anthropologist and in June 1927 the present writer was appointed to this post.

The work taken in hand by me on joining the department was

[1] Guide to the Musical Instruments exhibited in the Indian Museum, Calcutta, 1917.

[2] Guide Book No. 2—The Andamanese, Nicobarese and the Hill Tribes of Assam, Calcutta, 1919.

[3] Centenary Volume, p. 26, Calcutta, 1914.

[4] Centenary Volume, p. 24.

twofold : (1) the preparation of an accurate catalogue of the ethnographical objects and their intelligent display in the Gallery, and (2) the commencement of a systematic investigation of the racial characters of the races and tribes of India.

The preparation of an exhaustive and accurate catalogue of the ethnographical objects in our collections is a task of considerable magnitude. Due, as has been said, to the absence of a trained officer adequate and detailed records are not available in all cases, and even those that exist are not infrequently misleading and incorrect. Consequently before the specimens can be properly catalogued and scientifically and effectively displayed their correct identification is necessary. It will be apparent, however, from the very nature of the case that this work must necessarily be slow and will take many years to complete. Cataloguing and rearranging these objects is not the only task as the collections have very greatly to be augmented. At present we have materials only of the tribes of Assam and the Andaman and Nicobar Islands but for the rest of India we possess very little. If the Museum has to retain its all-India character and compare favourably with the Indian collections in the various Museums of Europe and America it is time that fresh collections are made from the primitive tribes of the various parts of India, specially in view of the rapid depopulation that is taking place among them. During my recent tours in South-Western India a valuable collection of ethnographical objects of the Kadirs and Malsers of the Cochin and Annaimallai Hills has been procured.

The work in the Anthropological Section did not so long include intensive research as in other departments of the Zoological Survey of India, with the exception of the investigations of Sir William Turner (*Transactions of the Royal Society of Edinburgh,* vol. xxxix, pt. iii; xlix, pt. iii) and of Mr. B. A. Gupte (*Craniological data from the Indian Museum,* 1909) on the osteological materials in our collections. The late Dr. Annandale, however, began an important anthropometric investigation of the Anglo-Indians of Bengal. His measurements and somatic observations were placed in the hands of Prof. P. C. Mahalanobis for statistical analysis, the first part of which was published in 1922.[1]

Since my appointment as Anthropologist in the Zoological Survey of India in June 1927 investigations in two important lines have been undertaken—one in connection with the racial characters of India's prehistoric inhabitants and the other regarding the somatology of the remnants of primitive tribes still surviving in the extreme interiors of the hills of this country.

Our existing knowledge of the racial characters of India's prehistoric inhabitants has been very meagre, but thanks to the discovery of human remains in different sites in the Indus Valley very important materials have at last been found for systematic research. Visits were paid by Lt.-Col. R. B. Seymour Sewell and myself to Mohenjo-daro and Harappa at the request of the

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[1] *Records of the Indian Museum,* vol. xxiii, p. 7 (1922).

Director-General of Archæology who placed the entire collection of human and animal remains in our hands. Our collections of the human remains from the Indus Valley sites now comprise (1) the remains found by Mr. Hargreaves at Nal, (2) those excavated in successive years at Mohenjo-daro, (3) the remains found at Harappa, and (4) the two skulls excavated by Sir Aurel Stein in Mekran. Investigations on these remains are being carried on jointly by Lt.-Col. R. B. Seymour Sewell and myself and our reports on numbers one and four are ready; the former is being published by the Archæological Survey and the latter is to be incorporated in the forthcoming work of Sir Aurel Stein.

For purposes of comparative study the two ancient skulls found at Bayana and Sialkot were procured by the Director through the courtesy of the Bombay Anthropological Society. The Madras Museum has also lent us its collection of human remains found at Adichannallar in the Tinnevelly District reported to be the earliest site in Southern India. Investigations on all these remains, as well as that on the skull found in a Mauryan site near Patna and brought by me last year, are proceeding, and, when completed, will, it is hoped, give us our first general idea of the racial characters of the ancient inhabitants of the different parts of India.

Besides the above the important collection of skulls of the head-hunting Naga tribes recovered by the Bernard Expedition in Burma has been sent to us for study. My report on these skulls worked in collaboration with Mr. P. C. Bose, M.SC., M.B., one of the research students working in this laboratory, is nearly complete and will shortly be published. Other collections of skulls received by us are:—

1. Four Andamanese skulls sent by Mr. J. M. Wright, Deputy Commissioner, Andamans.
2. Twenty skulls excavated and brought by Lt.-Col. R. B. Seymour Sewell from the Nicobar Islands.
3. Two Veddah skulls sent on loan by the Colombo Museum.

Remnants of primitive tribes still found in the extreme interiors of our hills are fast disappearing and in order to make a complete anthropological survey of these tribes before they entirely die out, two tours were undertaken by me in 1928 and 1929. During these tours I made an extensive survey of the Cochin and Annaimallai Hills and was able to secure valuable anthropometrical and ethnological materials of the primitive tribes of these hills. My investigations showed that in the extreme interiors of these hills remnants of a genuine Negrito race still exist of which a short account was published in *Nature* (May 18, 1928).

In addition to the above scientific study of Indian primitive technology as illustrated in the objects of our collections has been started and a paper prepared by Mr. P. C. Bose, M.SC., M.B., one of the research students working in this section, on the Head Dress of the Assam Hill tribes, has been accepted by the Asiatic Society for publication. Two of the research students are at present working on Indian Footwear and Offensive Weapons, whose reports, when completed, are expected to reveal new facts concerning occulturation in different parts of India.

NOTES ON SOME OF THE WILD SPECIES OF AROIDS

BY

C. McCANN,

Assistant Curator, Bombay Natural History Society, Bombay.

(3 plates and Text-figures)

The Araceae though not a very large order in the Bombay Presidency, being represented by 11 genera comprising 27 species present many difficulties, particularly the genus *Amorphophallus*. The reason for this state of affairs is not far to be sought, for most of the Aroids are typically monsoon plants and unless a collector is prepared to get wet and visit places where they grow several times during the season and in successive years, he will not succeed in obtaining a representative collection of these curious plants. Apart from this, they are difficult to preserve in the wet weather in a recognizable form, as there is great risk of their decaying and being attacked by mould which also destroys them beyond recognition.

Apart from these difficulties that have to be contended with in the field, there are other obstacles which are due to the fact that the genus *Amorphophallus* never produces flowers and leaves on the same plant in the same year. This necessitates the corms being brought home and kept till the next year for the flower or leaf as the case may be. This procedure is not always an easy one, but it is the only way in which we can clear up the confusion which has so very often been caused. The corms last quite well even if kept dry on a shelf. Even in this state the corm will show signs of life with the approach of the next monsoon and may then be transferred to a pot. One on a shelf in my laboratory (if it can be called so) put forth a new leaf after lying there for a year, at the opposite end of the corm to which the peduncle was attached the previous year,[1] and continued to grow in spite of having been left on the shelf for the rest of the rains. I must admit that the growth was not very vigorous, but this just shows the vitality of the plant. At the end of the rains like its fellows in the jungles it commenced to wither and dry up. A new corm was formed but this was small.

Another most interesting study is the development of the leaf from the 'simple' juvenile form to the complex pinnatified type in the mature state, but I do not propose to deal with this aspect of the plants in this note. To one who has had opportunities of studying these plants in the field the different species are easily recognizable especially when fresh.

For several years I have had certain isolated patches and separate individuals under observation both in pots and in their natural habitat away in the jungles of Salsette. I visited these places at different times during the monsoons and in different years, thus being able once and for all to assign the correct leaf to the correct flower. Below I give the results of my observations under the respective species, together with photographs.

Genus SAUROMATUM

Sauromatum guttatum, Schott, in Schott and Endlich. Meletem. (1832) p. 17.

The flowers of this plant appear from January to March and even as late as early April. They are very malodorous, not far removed from carrion, and the air in its vicinity is usually impregnated with their stench. The peduncle is very short, the spathe long and reflexed, resembling putrid flesh in colour. In fruit the peduncle is slightly longer than when in flower. The leaves appear soon after the break of the monsoon, and are always solitary. The leaves appear on the same corm as the flower in the same year. This is possibly due to the distant interval at which the corm flowers and leaves while in the next

[1] I find it in leaf again this monsoon (1930).

Fig. 1. Leaf of *Sauromatum guttatum*, Schott.

Fig. 2. Flower of *Amorphophallus commutatus*, Engler.

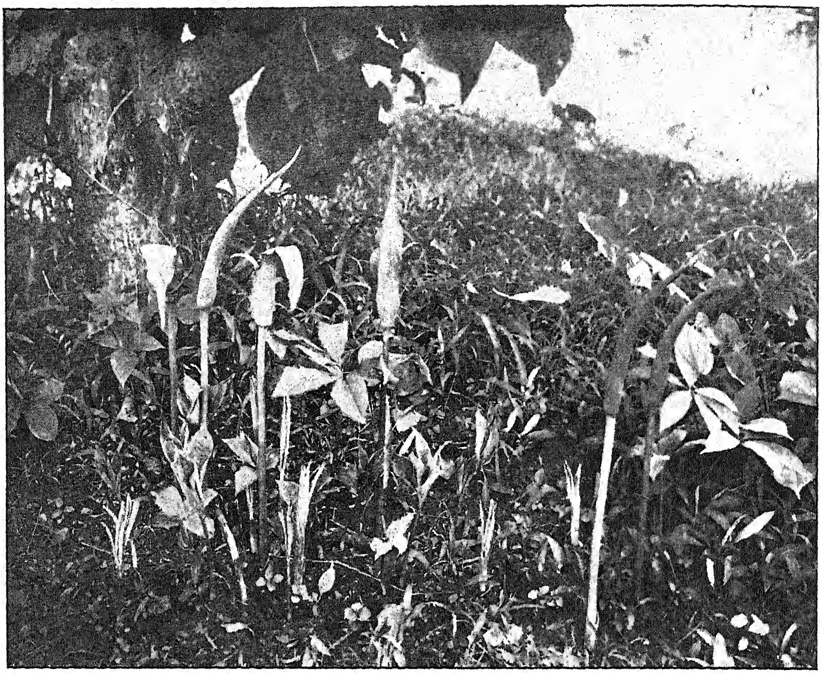

Fig. 1. A colony of *Amorphophallus commutatus*, Engler.

Fig. 2. Abortive specimen of *Amorphophallus commutatus*, Engler.

genus the flowering and vegetative period coincide. No reliance can be placed on the colour of the petiole as it is very variable, from a pale green throughout to a dark green and sometimes with darker blotches. (Plate I, Fig. 1.)

The leaf figured in the *Journal of the Bombay Natural History Society*, volume vii, p. 312 under the name *Pythonium Wallichianum*, Kunth, is of this plant. Cooke, in the Flora of the Bombay Presidency, in a foot-note has also pointed this out.

In the Islands of Bombay and Salsette this plant is not so often met with as *Amorphophallus commutatus*, Engler. It usually grows under the shade of trees or among shrubs and is very rarely found in the open.

Flowering : Uran, 14–1–18 (McCann !); Bhandup, 7–3–27 (McCann !).

Genus Amorphophallus

Amorphophallus bulbifer, Blume, Rumphia, v. i (1835) p. 148.

The occurrence of this plant within the Presidency is a new authentic record. Cooke in his Flora of the Bombay Presidency includes this species on the authority of Graham and Woodrow but has seen no specimens and remarks that there are none from this area in Herbarium Kew. This year (1929) I discovered this species growing here and there in the forest of the larger hills of Salsette. In 1927 and 1928 I had seen this plant but at the time mistook it for *A. commutatus*, thinking that this species also bore tubers on the leaves, but after closer examination found that it was altogether a different plant, *A. bulbifer*. Up to the time of writing I have not yet come across the flowers of this species but I have a fine specimen of its fruit.

The leaves are large in old well developed specimens, up to three feet and more in diameter (*vide* Cooke *l.c.* 12–18″) with one large tuber at the diversion of the three segments of the leaf and smaller ones at each of the bifurcations of the segments themselves, thus each leaf often possessing ten and even fourteen smaller tubers. The tubers depend in number on the size of the leaf, and are deeply imbedded in the tissue of the main 'nerves'. In cross section all tubers are pinkish to pinkish-purple in colour. The petiole sometimes attains the proportion of a man's wrist at the base, gradually diminishing upwards in thickness. In young leaves the 'stalk' of each segment of the leaf is horizontal (see Fig. 1), but in larger leaves they are very slightly raised from the horizontal position (this is *not* the case in either *A. campanulatus*, or in *A. commutatus*(see Fig. 2). The colour of the petiole, which

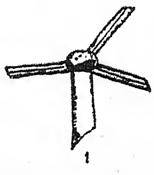

Fig. 1.—*Amorphophallus bulbifer*.

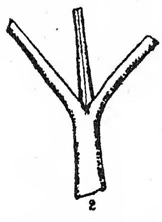

Fig. 2.—*Amorphophallus commutatus*. Showing (*a*) horizontal segments of petiole ; (*b*) vertical segments of petiole.

has long blackish and green markings, above the green turning to pink, and purple towards the base, is very constant in this species. The colour of the peduncles is almost like that of the petiole. Very rarely two leaves appear from the same corm in the same year, in this case the second leaf is very poorly developed.

The fruit is at first green but becomes scarlet when ripe.

The two main characters by which this species can be distinguished in the field are : (*a*) the bulbils on the leaves, (*b*) the typical colouring of the petiole or peduncle.

This is purely a forest species and so far has only been taken by me in the dense forests in the back hills of Salsette.

Fruiting Near the Kanari Caves, 22-9-29 (McCann !).

Localities: Hills near Ghorbunder (McCann !); Hills West of Muland (McCann !).

Near the Kanari Caves (McCann !).

There is a single specimen of this species in the Herbarium of the College of Science which was grown in the garden, but I do not know from where it was obtained.

Amorphophallus commutatus, Engler, in DC. Monog. Phan. v. 2 (1879) p. 319. (Plate I, Fig. 2.)

This is perhaps the commonest of the Aroids in the Islands of Bombay and Salsette growing everywhere in forests, under the shade of trees but rarely in the open, where the full strength of the sun catches them. The dimensions of the leaves are very often much larger than those given by Cooke's Flora of the Bombay Presidency. The petioles are very variable in colour and texture, and no description will exactly suit to describe them. They are sometimes, smooth, at others rough. Cooke in his description *l.c.* writes :—' Leaf solitary, appearing a month or more after the flowers ;' it is not quite clear from this statement whether he meant from the same corm as that on which the flowers appeared or on other corms. As far as my observations go the flowers and leaf never appear from the same corm in the same year. To this rule I have come across two exceptions and in these cases the tubers were exceptionally large for this species and in both cases both the flowers and the leaves were highly abortive (see Plate II, Fig. 2). The spathe and spadix were both abnormal, the latter carried fewer flowers. The leaf in each case was reduced to a mass of leaflets and abbreviated nerves all fused together in a heap. The peduncle is very variable in length and colour, and so is the spathe, in fact the whole plant is very variable. Injury to the peduncle brings about abortion in the spathe and spadix.

The angle of the 'stalks' of the segments is at about 45 degrees to the horizontal line (see Fig. 2.).

This species often forms small colonies of plants at different stages of development. Large specimens of this species are very difficult to distinguish from specimens of *A. campanulatus* when in leaf. (Plate II, Fig. 1.)

The flowers and leaves appear soon after the first rains (not on the same corm). By July these plants are all in fruit with the exception of some of the late arrivals. The flowers are offensive. Cooke writing on this point says :— 'The plant is very common at Matheran, where the flowers appear about the end of May. When the anthers are ripe, the odour of the plant is most offensive, resembling carrion, and visitors to the Hill often complain of *defective conservancy* at this time.'

The fruit becomes scarlet when ripe.

The colour of the tubers of this species is of a yellowish tinge quite unlike those of the preceding species.

Amorphophallus campanulatus, Blume, ex Decaisne, in Nouv. Ann. Mus. Par. v. 3 (1834) p. 366. (Plate III, Figs. 1 and 2.)

The tubers are large and usually appear 'tuberculate' with the remains of roots. A good illustration of the tuber is given in the *Journal of the Bombay Natural History Society*, v. ix (1894) p. 42. This is a rather characteristic point in the field. The leaves are large and variable, the petioles very variable in colour. The peduncle in flower is from $1\frac{1}{2}''$ to $3''$ but elongates to $9''$ when in fruit. The flowers are put forth in June soon after the first rains have fallen. The leaves appear about the same time and by July are fully formed. Kirtikar writing in the *Journal of the Bombay Natural History Society l.c.* says, 'Fruit.—Not yet known to have ever developed.' In my experience this is not the case as fruits are developed regularly by suitably sized tubers. Kirtikar's statement might be explained, by the fact that the fruits are soon lost to sight in the rank undergrowth which appears by the time the plant is in fruit (July-September, the period of development). The tuber is yellowish in section

This species is quite common throughout Salsette and grows in much the same habitat as the preceding species. It is not to be found in very open, sunny situations.

Concluding remarks on the genus: All the species are shade lovers. The flowers and leaves appear with the approach of the rains, but the tubers never flower and leaf in the same year. The leaves persist till the end of the

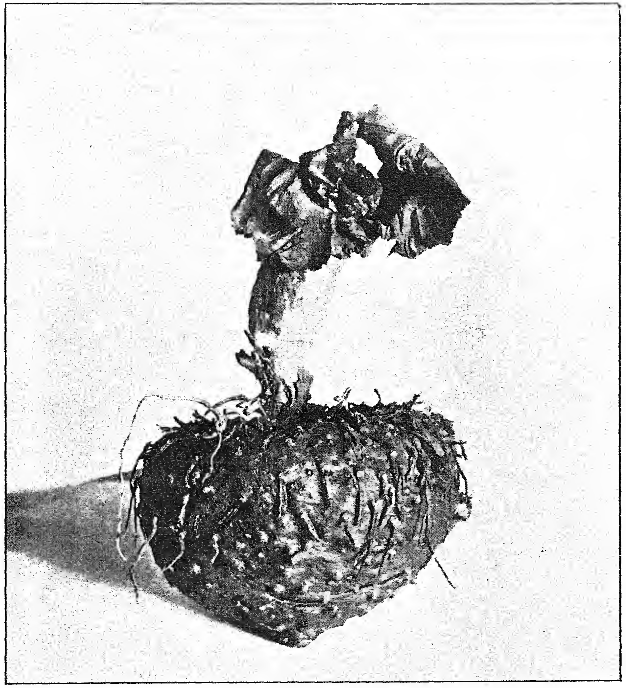

Fig. 1. Corm and withered flower of *Amorphophallus campanulatus*, Blume.

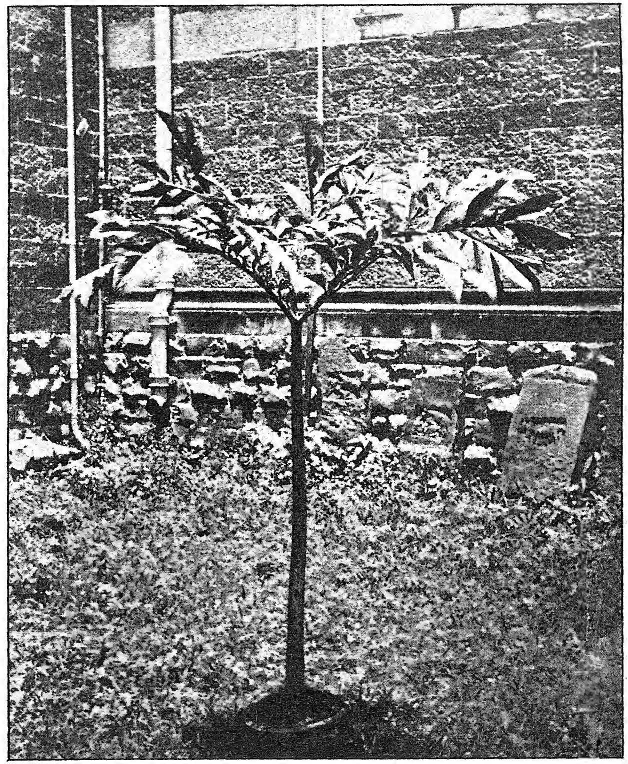

Fig. 2. Leaf of *Amorphophallus campanulatus*, Blume.

monsoons and then disappear. If the leaves are cut off no amount of persuasion will make the tuber leaf a second time in the same season. This I have tried both in 'potted' specimens and also in their natural habitat. If the tubers are placed in water for any length of time without the leaf, it will either rot early or give out numerous shoots all around the tuber, but I have never seen these shoots come to anything. These plants never flower till the corms have reached a good size (according to the species). The size of both the flowers and the leaves also depends on the size of the corm and is, therefore, very variable, particularly in the case of *A. commutatus*. As these plants take several years before they flower or fruit I hardly think that they should be classed as 'annuals' in spite of the fact that they appear only once every year during the monsoon. Even if watered regularly nothing will induce them to 'leaf' (*i.e.* keep on with the leaf) once the monsoons are over. The life of the individual is fairly long but how old they become I am unable to say.

Genus Ariopsis

Ariopsis peltata, Nimmo, ex Grah. Cat. Pl. Bo. (1839) p. 252.

A reference to Cooke's Flora of the Presidency will show that he has only seen a single specimen of this plant, collected by Stocks. Two more references are made to Dalzel & Gibson and Woodrow but he has not seen their specimens. This plant is exceedingly common throughout the hilly portions of the Island of Salsette. The leaves and flowers appear almost together soon after the break of the monsoons. The fruit ripens by the end of June and falls away from the plant thus leaving the leaves to persist throughout the monsoon. They seem partial to rocky situation near streams but are also to be commonly found carpeting the ground in the forests.

Cooke *l.c.* states that the corms of this plant are green, but as far as I have observed, this is not the case, instead they are yellowish when washed of the earth and are also light yellowish in section. Further, frequently two leaves appear from the same corm. Even the size of the leaves and petioles is much larger in well-developed examples than stated by Cooke. The petioles exceed a foot in length, and the leaf nine inches in diameter. Several flowers are put forth by the same corm.

In order to preserve specimens of Aroids well during the monsoon it is advisable to paint them in the field with a concentrated solution of corrosive sublimate and to repeat the process if necessary during the process of drying. I have done this with all my specimens and in this way have obtained excellent results. The application of the solution to other plants during the rains and particularly those whose leaves are easily detached by rot between the petiole and the branches, as in the *Leguminosae* and a few other orders, will always produce good results.

THE BOMBAY NATURAL HISTORY SOCIETY'S INVESTIGATION INTO THE COMPOSITION OF SALT-LICKS.

EARTH-EATING AND SALT-LICKING IN INDIA.

BY

J. F. CAIUS, S.J., F.L.S.,

AND

K. H. BHARUCHA, B.A., B.SC.,

(*Pharmacological Laboratory, Parel, Bombay*).

PART III

(*Continued from page 222 of this volume*)

ANALYSES VIII–XIII

VIII. COMMON EARTH

SERIAL No. 7b.

LOCALITY—Bellatur, Kolegal Taluka, Mysore.
OBTAINED AND SENT BY—Mr. R. C. Morris, Honnametti Estate, Attikan P.O., *via* Mysore.

Hard lumps of very dark brown earth. Powder gritty.

Minerals (mostly quartz)	10·28	per cent.
Clay	50·26	,,
Sand	30·56	,,
Organic debris	0·24	,,
Moisture	5·84	,,
Fine Earth (20 mesh sieve)	83·88	,,
Insoluble in nitric acid	64·688	,,
Soda (Na_2O)	2·429	,,
Potash (K_2O)	2·260	,,
Magnesia (MgO)	0·224	,,
Lime (CaO)	0·335	,,
Alumina (Al_2O_3)	7·206	,,
Silica (SiO_2) soluble	0·564	,,
Phosphorus (P_2O_5)	0·159	,,
Sulphur (SO_3)	0·059	,,
Chlorine (Cl)	1·490	,,
Ferric oxide (Fe_2O_3)	3·575	,,
Moisture and organic matter	1·000	,,

Remarks.—1. The soil contains traces of humus and manganese.

2. The earth was taken from an area adjoining salt-lick No. 7a.

IX. Soil from Salt-Lick (Irul Lecki)

Serial No. 16.

Locality—Mysore.
Obtained and sent by—Mr. R. C. Morris, Honnametti Estate, Attikan P. O., Mysore.

Hard clayish lumps, greyish brown mottled with white; with roots and seeds. Powder rough.

Minerals (mostly quartz)	13·52	per cent.
Clay	24·74	,,
Sand	49·41	,,
Moisture	6·71	,,
Fine Earth (20 mesh sieve)	79·77	,,
Insoluble in nitric acid	60·840	,,
Soda (Na_2O)	0·074	,,
Potash (K_2O)	4·270	,,
Magnesia (MgO)	0·464	,,
Lime(CaO)	1·924	,,
Alumina (Al_2O_3)	5·127	,,
Silica (SiO_2) soluble	0·890	,,
Ferric oxide (Fe_2O_3)	1·787	,,
Moisture and organic matter	4·300	,,

Remarks.—The soil contains traces of phosphorus, manganese and sulphur.

X. Soil from Salt-Lick (Bellul Lecki)

Serial No. 17.

Locality—Mysore.
Obtained and sent by—Mr. R. C. Morris, Honnametti Estate, Attikan P.O., Mysore.

Hard clayish lumps, greyish brown mottled with white; with rootlets and seeds. Powder rough.

Minerals (mostly quartz)	8·86	per cent.
Clay	40·41	,,
Sand	35·30	,,
Organic debris	0·39	,,
Moisture	7·83	,,
Fine Earth (20 mesh sieve)	83·31	,,
Insoluble in nitric acid	67·480	,,
Soda (Na_2O)	0·954	,,
Potash (K_2O)	3·411	,,
Magnesia (MgO)	0·663	,,
Lime (CaO)	1·470	,,
Alumina (Al_2O_3)	3·450	,,
Silica (SiO_2) soluble	0·148	,,
Phosphorus (P_2O_5)	1·399	,,
Ferric oxide (Fe_2O_3)	2·261	,,
Moisture and organic matter	2·000	,,

Remarks.—The soil contains traces of sulphur and manganese.

XI. Earth for Human Consumption.

Serial No. 111.

Locality—Mysore.
Obtained and sent by—Mr. R. C. Morris, Honnametti Estate, Attikan P. O., Mysore.

Hard lumps of dark ferruginous brown earth. Powder gritty.

Minerals	1·52	per cent.
Clay	58·74	,,
Sand	15·35	,,
Organic debris	1·01	,,
Humus	12·85	,,
Moisture	7·36	,,
Fine Earth (20 mesh sieve)	91·12	,,
Insoluble in nitric acid	64·121	,,
Potash (K_2O)	6·173	,,
Magnesia (MgO)	0·483	,,
Lime (CaO)	0·379	,,
Alumina (Al_2O_3)	9·903	,,
Silica (SiO_2) soluble	0·840	,,
Phosphorus (P_2O_5)	2·123	,,
Ferric oxide (Fe_2O_3)	5·290	,,
Moisture and organic matter	0·970	,,

Remarks.—1. The earth contains traces of sodium, sulphur, and manganese.

2. It is eaten by Canarese women when pregnant.

XII. Medicinal Earth.

Serial No. 232.

Locality—A spring in Sokotra.
Obtained and sent by—Dr. P. W. Harrison, M.D., Muscat, Persian Gulf.

White rough powder, and white lumps easily crumbling to powder.

Fine Earth	100·000	per cent.
Insoluble in nitric acid	1·652	,,
Soda (Na_2O)	3·489	,,
Magnesia (MgO)	5·164	,,
Lime (CaO)	45 850	,,
Alumina (Al_2O_3)	1·400	,,
Carbon dioxide (CO_2)	39·010	,,
Moisture and organic matter	2·920	,,

Remarks —1. The earth contains traces of iron and soluble silica.

2. It is credited with extraordinary medical virtues by the Arabs.

XIII. Soil from Salt-Lick.

Serial No. 90.

Locality—Close to a forest bungalow called Gola Tappar; 1,200 feet above sea level in the Dun about 20 miles east of Dehra Dun.

Obtained and sent by—Mr. A. E. Osmaston, Officiating Conservator of Forests, Working Plans Circle, Naini Tal, U. P.

Light buff hard clayish lumps. Powder soft.

Minerals	2·83	per cent.
Clay	44·72	,,
Sand	49·42	,,
Organic debris	0·45	,,
Moisture	3·70	,,

Fine Earth (20 mesh sieve)	93·47	per cent.
Insoluble in nitric acid	83·198	,,
Potash (K_2O)	4·674	,,
Magnesia (MgO)	0·880	,,
Lime (CaO)	0·315	,,
Alumina (Al_2O_3)	3·682	,,
Silica (SiO_2) soluble	1·060	,,
Sulphur (SO_3)	2·511	,,
Phosphorus (P_2O_5)	0·027	,,
Ferric oxide (Fe_2O_3)	3·718	,,
Moisture and organic matter	0·620	,,

Remarks.—1. The soil contains traces of humus, sodium, manganese, and chlorine.

2. The lick is surrounded by Sal forests and frequented by chital.

THE TOXICITY OF THE VENOMS OF INDIAN SCORPIONS.

PROGRESS OF THE SOCIETY'S INVESTIGATION.

SCORPION VENOM.

The statement shows the total amount of venom collected, since the publication of the last list on page 230 of this volume.

	Number of Scorpions.	Weight of dry Venom in milligrams.
Butheolus bicolor ...	1	0·0
,, *melanurus* ...	5	0·0
Buthus australis ...	3	2·0
,, *pachyurus* ...	57	25·5
,, *rugiscutis* ...	12	2 6
,, *tamulus* ...	379	823·0
Palamnaeus bengalensis ...	2	9·7
,, *fulvipes* ...	56	196 7
,, *gravimanus* ...	4	14·6
,, *liurus* ...	20	13·6
,, *longimanus* ...	5	18·5
,, *phipsoni* ...	16	74·8
,, *swammerdami* ...	46	684·7
,, *xanthopus* ...	5	16·3
Scorpiops asthenurus ...	5	5·6
,, *montanus* ...	7	3·6
Isometrus europaeus (vesicles).	10	7·9

PHARMACOLOGICAL LABORATORY,
PAREL, BOMBAY,
April 10, 1930.

J. F. CAIUS.

OBITUARY.

HERBERT CHRISTOPHER ROBINSON.

Herbert Christopher Robinson, who was born in Liverpool in 1874 and became a member of the Society in 1911, died in 1929 at Oxford after a long illness. His active biological career began in 1896 with a visit to Queensland where he made a collection of birds. From 1897 to 1900 he was an assistant in the Liverpool Museum where he collaborated with Dr. H. O. Forbes in the production of catalogues of the important bird collection of the Museum. In 1901 and 1902 he and the late Dr. Nelson Annandale, who became eventually Director of the Zoological Survey of India, were jointly engaged in travel and research in the Malay Peninsula the results of which, both ethnographical and zoological, were published under the title 'Fasciculi Malayenses.' In 1903, Robinson became Curator of the Selangor Museum and Inspector of Fisheries, Federated Malay States, and in 1908, Director of Museums and Fisheries, F.M.S.

Besides his regular duties, he organized and for some years controlled a Meteorological service, primarily in connection with a search for hill-station sites; and he organized, and was in charge of, the Arts and Crafts section of the Malayan Pavilion at the British Empire Exhibition. He retired on pension in February 1926.

Robinson was a man of unusual ability: there were few subjects he could not master in a short time: though later he specialized on mammals and birds of Malaysia, he was possessed of wide knowledge of, and competence in, anthropology, zoology and botany.

Robinson had long planned to produce a set of volumes on the Vertebrate Fauna of the Malay Peninsula, analogous to those of the *Fauna of British India* series and in 1912, there was published under his editorship a volume on the Reptilia and Batrachia by Dr. G. E. Boulenger. It was his intention to produce the other sections in collaboration with the writer of this notice but, the war, the demands made by their current work on the time of both, and the various duties Robinson undertook for Government outside those of his appointment made this impossible, and the task was deferred until his retirement on pension, when it was still further postponed by the request of his Government that he should first produce the less purely systematic work on 'The Birds of the Malay Peninsula' on which he was engaged, when he succumbed to his final illness and of which he completed two of the five volumes projected. Shortly before he became incapacitated, he was elected co-editor of *Ibis*. Under his direction were issued some eleven volumes of the *Journal of the Federated Malay States Museum* which contain many papers written by him.

Though a number of his reports, especially those on the zoology of Siam (of which the most important is perhaps that on 'The Birds of South-west and Peninsular Siam') [1] cannot be overlooked by workers on Burmese zoology as there is much in common to the fauna of the two countries, Robinson wrote few papers on the *Fauna of British India* and contributed none to the Society's Journal. His 'Indian' papers are :—

1. Zoological Results of the Abor Expedition: Mammals. *Rec. Ind. Mus.*, viii, 1913, pp. 85–98.
2. On two new sub-species of squirrel from Southern India. *Rec. Ind. Mus.*, xiii, 1917, pp. 41–2.
3. On two abnormal specimens of Ducks in the collection of the Zoological Survey of India. *Rec. Ind. Mus.*, xv, 1918, pp. 47–8, pl. III.
4. A new race of hare from the Persian Frontier of Mesopotamia. *Rec. Ind. Mus.*, xv, 1918, pp. 49–50.
5. A nominal list of the Sciuridae of the Oriental region with a list of the specimens in the collection of the Zoological Survey of India. *Rec. Ind. Mus.*, xv, 1918, pp. 171–254.
6. On the proper name of the Red Jungle-fowl from Peninsular India. *Rec. Ind. Mus.*, xix, 1920, pp. 13–15.
7. Notes on Viverridae. *Rec. Ind. Mus.*, xix, 1920, pp. 175–9.
8. Some remarks on Mr. Stuart Baker's new volume on the Birds in the *Fauna of British India. Journ. Asiat. Soc., Bengal*, xviii, 1922, pp. 559–68.

Besides his early visit to Australia and his many journeys in the Malay States, Robinson visited, for the purpose of biological investigation, the Siamese portion of the Malay Peninsula, the Rio-Lingga Islands, Sumatra and Java. He had travelled in India and during the war was on service at Basra: when on furlough he always paid long visits to Switzerland, for mountains had a great attraction for him, but in the East what he perhaps enjoyed most was cruising on inspection in his Fisheries launch.

C. B. K.

JOHN CHAMPION FAUNTHORPE

The Society has been deprived of an active, helpful member and the Indian Civil Service of a great sportsman by the death of Lt.-Col. John Champion Faunthorpe, C.B.E., M.C., A.D.C. to the King. The following is an extract from an obituary notice which appeared in *The Times* of the 4th December 1929 :—

He was a great athlete, excelling in almost every form of strenuous sport, and by collections of large and small mammals, birds, and reptiles he made substantial contributions to the study of natural history.

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[1] *Journ. Nat. Hist. Soc., Siam*, v, 1921–4, pp. 1–397.

The son of a clergyman, he was born on May 30, 1872, and was educated at Rossal School and Balliol College, Oxford. He rowed in the first Torpid, but specialized in rifle shooting, and was in the University Shooting Eight and Long-range Team. He passed the Indian Civil Service examination at the age of 19, and in the autumn of 1892 he went out to what are now the United Provinces. Occasional spells of secretariat work never appealed to him, for he preferred the open-air life of the district officer. Horse-racing, pig-sticking, polo, and big-game shooting were his chief sports, but he was also keen on walking expeditions and on the promotion of volunteering. It was for his services as a leader of Light Horse that he received the Volunteer Decoration, and in 1922 was made A.D.C. to the King. He was appointed to the 7th United Provinces Horse on its reconstitution as a unit of the Indian Defence Force in 1917. A very fine shot, Faunthorpe, was also a remarkably capable organizer of big-game shoots. He understood, as by instinct, the manners and habits of the wild creatures of the Indian jungles, and was singularly successful in the management of elephants on shooting expeditions. He was idolized by his beaters, and could arrange a tiger beat as well as any professional *shikari*.

When the War came, he was discovered to be very good at intelligence work. He was on military duty under the War Office in this capacity, and at an early stage was appointed Military Director of Kinematograph Operations on the Western Front. Frequently with his photographers he worked under enemy fire. The battle film of the Somme, which he supervised, was shown to vast audiences throughout the country, and, like other films of the series, did much to encourage the British public to maintain the home front. In 1919–20 he was attached to the British Embassy at Washington on intelligence work, rounding up Indian agitators. He was very popular there, as in India, and the remark was made by a prominent citizen that he was the typical, alert, resourceful Englishman.

The link with the United States was destined to be prolonged. Faunthorpe returned to civilian duty in 1920 as Commissioner of Lucknow. In the cold weather of 1922–23 he was placed on special duty for a six months' game-shooting expedition in Northern India and Nepal to obtain specimens for the American Museum of Natural History, New York, and the Field Museum at Chicago. With him was Mr. Arthur S. Vernay, who made the preliminary arrangements in America and bore a great part of the cost. Some 450 specimens were collected, including many rare birds and interesting reptiles. Groups of all the important animals of the plains of India were obtained, with the exception of the Indian buffalo and the Indian lion, and no animal got away wounded. Colonel Faunthorpe described the expedition most picturesquely in articles in *The Times* of September 7 and 8, 1923. Some 27,000 ft. of film was secured, and the film, under the title of 'Jungle Life in India,' was widely exhibited in this country and America. Subsequently Faunthorpe took an expedition to the Kathiawar State of Junagadh to collect for New York specimens

of the Indian lion, now only to be found in the Gir forest there. He succeeded in bagging two lions and a lioness; the former had manes, and were of the distinctly African type, contrary to what had been widely alleged.

Faunthorpe, who frequently shot for India at Bisley, retired from the I. C. S. in 1925. He went out to India a few weeks back to visit his beloved Light Horse and to collect more big game specimens for America. He married, in 1896, a daughter of Major J. T. Ryves, India Police, and she is now in this country. They had two sons.

REVIEWS.

1. BIRD HAUNTS AND BIRD BEHAVIOUR.—By Chas. E. Raven, D.D. Martin Hopkinson, London. 10*s*. 6*d*. net.

To the bird lover, or for that matter to any lover of nature, a book by Canon Raven is always a delight.

His enthusiasm is given full play through some 200 pages of charming and easy expression which takes one along with him to Oxfordshire 'on a day of wind and sun and great white clouds from the Hill beyond Nettlebed': to the west of Ireland and its Choughs, to Texel and Anglesey where nest the Heron and the uncouth Cormorant.

Each chapter gives an exquisite picture of a subject obviously dear to the author and finishes on an interesting note of philosophic speculation.

At times perhaps the practical collector or observer might be given to criticize a slight tendency to rhapsody—'The song of wrens breaking into the throbbing of the car'—while the casual reader might find surprise in a rather heavy description of a tiny bird such as the Grey Wagtail, the loveliest of its kind, 'a clear saffron ranging from the poignancy of dawn to the full blaze of sunset, a tint that no pigment can match. His grey back and the black cravat beneath his chin, themselves of an almost sombre neatness are incomparably fitted to redeem his splendour from garishness and to create an air of distinction.'

On the other hand, who can fail to be thrilled at the memory of a Saint's Day, and above all of St. Barnabas? 'June the 11th is good for the bird lover and for the butterfly collector, if his school is in Rutland, it is superb. Year by year we were carried in an antiquated waggonette to Wakerly and let loose upon the woods that once were part of the vast Rockingham Forest.'

There are two subjects of observation and description which stand out from even the many good things that appear in this excellent book One is that untiring bit of fascination—the Dipper.

'He sets off down stream along the brink turning over dry leaves and grass, peering into crannies, running out into the water where the bank is steep and swimming for a few yards where the current slides smoothly by the shore. . . . Reaching the downward limit of fishing ground he starts to work upstream and leaves the bank for the mid-current. Now is the time to study his methods under water. . . . In the shallows he darts into the flood bobbing in and out, but holding fast to the ground. He moves very swiftly in a spasm of energy as restless as the stream. In deeper places he dives, springing into the water head first and using his wings to carry on the impetus of his plunge. When fishing, he usually dives right into the current: while his head is lowered, the pressure of the water inevitably sinks him. When he dives athwart the current he can travel much further, 5 or 6 feet perhaps without emerging; but this is when he wants to cross from one side to the other. For pools of greater depth, he has other devices. If there is a steep rock overhanging, he runs from the top and drops perpendicularly down with neck extended, wings closed and foot held well back—perhaps the strangest attitude that any bird assumes. If there is no convenient jumping off place, he flies up, hovers for a moment, lowers his head, shuts his wings and plunges from the air dropping a yard or so before striking the water. To describe such movements in dull prose is to destroy their charm: to watch them performed in quick time is to be kept in a constant state of excitement.'

The marvel of the nest with its hanging curtain of moss built out from the stone cavity in the bridge and looking, for all the world, just like another moss-covered stone might well be 'highly ingenious and unique among the structures built by British birds.'

The other subject is the Chough. Do birds 'play'? The reader will find the answer for himself in Valentia or, failing a visit in person there, he can do far worse than enjoy the highly entertaining description of this most mercurial and temperamental of birds.

This book is well illustrated with 16 photographs. Some of them are remarkable, especially the Fulmar swinging round in flight and showing wings held rigidly horizontal, while the pivot is made on an easy curve without any stroke of pinion. The bird is skimming along past the observer parallel to the face of the rock.

To those who want a breath of really fresh air or an hour's delightful entertainment, we can recommend this well-written and fascinating study.

P. M. D. S.

2. THE THIRD ANNUAL REPORT AND RECORDS OF THE CENTRAL PROVINCES ANGLING ASSOCIATION (HEAD-QUARTERS—JUBBULPORE).—Printed for the Association and sold at their office in Jubbulpore. Price Rs. 2. (Issued free to members) 1929.

This Association originated early in 1927 when a small number of enthusiastic anglers met together in Jubbulpore and discussed the advantages of forming an Association. It was decided to call a meeting of those interested in angling, and, if the necessary support was forthcoming, to consider formally the question of forming an Association.

This meeting was held at the Nerbudda Club, Jubbulpore, on March 7, 1927, at which thirteen gentlemen were present, with the Commissioner of Jubbulpore, Mr. C. J. Irwin, C.I.E., I.C.S., in the chair. It was then unanimously decided to form a Fishing Association, and that the name of the Association should be 'The Central Provinces Angling Association'. The Association dates therefore from March 7, 1927.

The objects of the Association are, to quote from their First Annual Report, 'to collect and maintain all records relating to fishes and fishing, and generally to consider the adoption of any course or methods which might further the advancement of or improve the sport of Angling in the Central Provinces.'

Colonel (now Brigadier) A. Campbell Ross, D.S.O., was elected the first President of the Association, and Captain (now Major) G. H. Chambers, M.C., and Major W. B. Trevenen, T.D., were elected as Joint Honorary Secretaries, the report being edited by the latter.

The membership of the Association now numbers over fifty, which fact speaks well for the enthusiasm with which the formation of the Association has been welcomed. One of the main features of the report is the publication of all the information obtained to date regarding the various fishing localities in the C.P. The Central Provinces are well served in the way of rivers, and of these sixteen already appear in the Report under review, with a description of the actual localities situated thereon so far as information has been obtained up to the date of publication. A certain amount of information regarding tanks and reservoirs also appears.

As the number of members gradually spreads over the C.P. so will the available information become more complete and one of the ultimate aims of the Association is to publish an 'Anglers' Guide' for the whole of the Central Provinces, which should prove a boon to all anglers resident in or visiting that part of India. In the meantime the report published yearly by the Association proves a temporary but very helpful substitute.

A list of the principal fish recorded for each river during the past season appears in the report, and also a record of the largest fish of species obtained since the Association was formed. An up-to-date list of the various species identified is also published.

The financial position of the Association appears very satisfactory, there being a credit balance of Rs. 786 at the close of the financial year.

Another feature of the report is the various articles on angling, both local and in other parts, and also an interesting collection of short miscellaneous articles written by members of the Association concerning their personal experiences or observations during the previous season. These articles are not necessarily confined to angling but may include any sporting experiences or observations which are likely to be of interest to the general body of members.

Under the head of NOTICES, we note an appeal from the Honorary Secretary of the Association to all anglers in the C.P. to forward to him for publication any information regarding the fishing in any of the rivers of the C.P. which has not already appeared in the report, and thus enable him to publish a really valuable list of 'Localities' in the next issue, and in endorsing this appeal, we would recommend all anglers in the C.P. who have not yet joined the Association to become members at once, and so further this most praiseworthy effort which is being made for the benefit of anglers in India.

The cost of joining the Association is only Rs. 9 as an out-station member, and thereafter an annual subscription of Rs. 2-8, in return for which, a free copy of the report is issued to all members. Resident members, i.e., in Jubbulpore, pay, in addition to the above sum a monthly subscription of Rs. 3. A small extra charge is made for any member fishing in waters baited by the Association.

Any enquiries or orders for the Annual Report, 1929, should be addressed to the Honorory Secretary, Central Provinces Angling Association, Jubbulpore.

The final two pages of the report contain a list of the members of the Association.

3. GROWTH AND TROPIC MOVEMENTS OF PLANTS.—By Jagadis Chunder Bose. With 229 Illustrations. pp. i–xxix + 447. Longmans, Green and Co., London, 1929. Price 21 sh. net.

Bose says in the Preface : 'Unfounded speculation has often obstructed the advance of knowledge; facts must supersede speculation, for it is not the pre-conceived bias of the observer, but unimpeachable facts that alone can lead to the establishment of sound theory.' This is a sound principle and we all admit it. If Bose had followed it, several of his works would carry more conviction than they do.

In the preface of his *Plant Response* (1906) he stated that the aim of his work was the demonstration of the unity of physiological mechanism of the plant with that of the animal, as evidenced by the script of the plant, and not the treatment 'of known aspects of plant-movements which is to be found detailed, together with the history of the subject, in standard books of reference on plant-physiology, such as those of Sachs, Pfeffer, Strasburger, Darwin, Francis Darwin, Vines and Detmer.' Since then Bose has, in books and lectures, repeated that pre-conceived idea of 'unity of physiological mechanism' without adding one more convincing argument.

Two years ago we had from his pen the *Motor Mechanism of Plants* in which he gave an account of the motor mechanism of adult members e.g. the leaves of sensitive and other plants. In the present volume he deals with a special kind of phenomena, the so-called tropic movements caused by external stimulation. Tropisms form a highly fascinating subject in plant-physiology and one that has received the attention of many able investigators in Europe and America during the last 40 years. The problems are innumerable. Amongst those which Bose has discussed are : Quantitative determination of changes induced in growth under variation of external conditions ; the modifying influence of tonic condition in response to external stimulation ; the effect of radiant energy through a wide range of the etherial spectrum ; the modification of tropic curvature by transverse conduction of excitation ; torsional response under lateral stimulation, etc., etc.

In every chapter the problem is clearly stated, then follows the description of the corresponding experiment with a diagram or curve, and from these generalizations and conclusions are derived. The method is excellent, and there is nothing to be said against the experiments. 'I have in this,' says Bose, 'and in my previous works, employed several independent methods of experimentation, whose concordant testimony could leave no doubt as to the authenticity of the newly discovered facts. . . The perfect reliability of my highly sensitive instruments has been repeatedly verified at various scientific centres both in the West and in the East. . . Professor Hans Molisch, lately Director of the Plant-Physiological Institute, Vienna University, during his recent visit to my institute, was able to repeat, with invariable success, many of the experiments described in this volume. His account of some of these will be found in *Nature* of August 4, 1928, and of April 13, 1929.'

We never had the slightest doubt about the reliability of Bose's instruments. On the contrary we admired his genius in devising apparatus and instrumental appliances. We are also convinced that the curves reproduced in his book are correct, i.e. the 'script of the plant'—but we cannot help thinking that in most cases the conclusions have been drawn too hastily. After all a curve is a curve and not more, representing the end-effects of a continued or interrupted stimulation, but it does not say anything regarding the most complex processes that are going on before tropic movements take place. A strict analysis of those processes is essential before we can draw reliable conclusions and each member in that chain of happenings would have to be dealt with separately. It is a well-known fact that the single members which lie between the points of perception and final (visible) reaction can be affected quite differently by the change of one external factor. The fact alone, e.g. that a wound may stop tropic movement for a time, does not allow us to decide whether the wound has prevented the perception of or reaction to the stimulus or both, as the elimination of one member in the chain leading from the point of perception to the point of reaction is quite sufficient to stop every movement.

If we wish to know what Bose has achieved by his recent work, the author himself refers the reader in the preface (pp. ix and x) to a few of the more important results. He has shown that the sensitivity of plants to the ethereal spectrum extends far beyond the infra-red region, that by transverse conduction of excitation across the organ, the response becomes gradually transformed from the positive to the negative, and that the irritability of the root is in no way different from that of the shoot. Whilst investigating geotropism, he determined the exact direction of the incident stimulus. He also demonstrated the torsional response of dorsiventral organs under different modes of lateral stimulation, and, finally, 'a wide generalization has been established which includes within its scope the diverse tropic movements of plant-organs.' It is easy to make a 'wide generalization', but whether it has been 'established' or should be disestablished' we leave to those specialists who are able and willing to look at a question from more than one point of view and are, therefore, less inclined to jump at conclusions.

E. B.

4. FIRST STEPS IN ZOOLOGY (ILLUSTRATED).—By Bonavis Bonnell. Pp. xiv + 182. Kesari Printing Works, Madras. 1929. Re. 1-8-0.

As a general rule, in India, there is a great dearth of suitable text-books of Nature Study dealing with Indian types. And in spite of the attempts that have been made in recent years to supply this want, the number still continues to be disappointingly small, considering the size of the country and the variety of its flora and fauna. Owing perhaps to the ease with which plants can be obtained and studied and, in India, also to the Indian sentiment and prejudice against taking life (life being more or less synonymous with animal life) Nature Study here on account of its being considered more 'clean' and less 'objectionable' has meant little more than the study of plants. In accordance with this popular sentiment, therefore, more books on Indian types are available in Botany than in the equally useful sister science of Zoology. The present publication is therefore all the more welcome.

Being primarily written for schools in South India, the author has naturally concentrated his attention on types which are characteristic of, or easily obtainable in, that part of the country. But a large number of types included therein are also common to other parts of India; and at all events the descriptions can, with minor alterations, be adapted to types in other parts of the country. In order to complete the picture, some Australian types have also been included.

The plan of the book is simple. The entire animal kingdom is divided into the Vertebrates and the Invertebrates. Each of these is again sub-divided into its principal phyla, and their characteristics briefly told. For the obvious convenience of study, the Vertebrates are treated first and they take up nearly three-fourths of the entire book. The remaining portion, with the exception of the concluding chapter, is taken up by the Invertebrates, where only the convenient and well-known types are dealt with.

In dealing with the phyla, general characters of the phylum are first given. This is followed by a detailed description of the type chosen. The treatment is from all points of view—within the limits of the space. Explanations of many general biological facts, e.g., adaptations to surroundings, geographical distribution, etc., and other facts of general information, enhance the usefulness of the descriptions and make the book readable. This is followed by brief descriptions of other allied types and, when known, the economic importance of the group is mentioned.

The concluding chapter deals with general biological facts such as Colouration, Mimicry, Life-histories of Animals, Ebb and Flow of Life, Balance in Nature, Adaptations to Water and Flight, etc. With advantage this might have been larger and fuller ; but even as it is, it gives a useful bird's eye view.

The book is fully illustrated and the text is simple. The first few pages contain some printing mistakes. On page 2 there are some misleading remarks on the comparison of animals and plants and the last sentence of the paragraph is certainly incorrect. 'Saprophytic' should have been 'Holophytic'.

The price of the book is reasonable.

N. K. T.

5. THE FLORA OF THE INDUS DELTA.—By Blatter, E., Mc Cann, C. and Sabnis, T. S. P. p. 173. 1 map, 59 photographs, viii plates and 18 graphs. The Methodist Publishing House, Madras. 1929. Price Rs. 7.

The work is a collection, in book form, of a series of articles by the authors which appeared between 1927 to 1929 in the *Journal of the Indian Botanical Society*. It embodies, as the authors say in the preface, 'the botanical results of a tour undertaken into the Indus Delta'—a region practically unexplored botanically. In investigating this region, therefore, and publishing their results, the authors have done a very valuable service to the cause of Indian Botany, for which they deserve the thanks of all interested in this science.

The work is divided into several parts. These are, unfortunately, not satisfactorily indicated in the table of contents. The first part, after a brief introduction, gives the list of species arranged according to Bentham and Hooker's system. In this list the cultivated and the planted species are distinguished from the others. The locality of each in the Delta is given and the distribution of most is mentioned.

The second part gives a detailed account of the Delta, and contains a full treatment of the various factors influencing the vegetation, e.g. climatic and edaphic. Many useful graphs accompany the text.

The third part is devoted to plant-geographical considerations, and is full of many interesting data carefully analysed, collated and tabled. It is the most important part, since it forms the basis of conclusions, on the origin of the flora and its comparison with the flora of the Sunderbans dealt with later on. A good deal of care, attention and labour have naturally been bestowed in bringing together the information and presenting it in a lucid manner.

The remaining two parts respectively give brief ecological notes on the area and deal with physiological plant anatomy. The former has the species, occurring in the different localities, arranged according to their characteristic habitats. The authors admit that they had not sufficient time for prolonged investigations into plant-ecological conditions of the Delta as 'Sea-sickness, heat, hunger and thirst had produced that feeling in us under whose influence even enthusiastic men lose all scientific interest.' But, as they themselves express the hope, these will certainly be of the utmost utility to the future visitors who may desire to extend the present investigations.

Some brief remarks may be offered on the conclusions reached by the authors on the affinities and the origin of the flora, and its comparison with that of the Sunderbans. With regard to the former, on the basis of plant-geographical considerations, 16 groups of plants, belonging to different elements, are distinguished. Of these only six species are provisionally considered as endemic on account of their not being reported from the neighbour-

ing regions. The authors, however, say that it is more than likely that, when these areas are carefully explored, the species in question may be found there also. The remaining species are found to belong to three distinct elements—an eastern, a western, and a more general, including purely Indian species. On analysis it is found that there is a great preponderance of the western element over the eastern in the Delta, the latter forming only one-seventh of the former. This is rather surprising as the ecological conditions of the Delta would appear not to exclude the Indo-Malayan types entirely. On the basis of the distribution of the species, the conclusion reached on the origin of the flora is that it is comparatively recent as, even in the present imperfect state of knowledge, out of 279 species as many as 226 are found in other parts of Sind. Necessarily the contributions have come from the neighbouring countries of Cutch, the Rajputana desert, the Panjab, Baluchistan, the West Coast of the Peninsula, Gujerat, Konkan and Deccan, on the assumption that plants in their migrations follow the lines of least resistance.

The comparison with the flora of the Sunderbans leads to certain surprising and hitherto little suspected results. So far the prevalent impression, following Hooker's erroneous statement, has been that the floras of the two areas are more or less the repetition of the same, albeit with a larger number of species comprised in the Sunderbans. The present investigation, however, leads the authors to an entirely different conclusion. Even in the present imperfect state of knowledge, out of 87 families and 336 genera, only 46 families and 67 genera are found to be common to both. Of the remainder some only are exclusively found in the one and some only in the other. The difference becomes still more striking when the number of species is considered, for out of the total number, only 48 have been found to occur commonly in both, and most of these are of very wide distribution. The conclusions of the authors, therefore, are:

1. The Indus delta does not repeat the vegetation of the Sunderbans.
2. The purely eastern element is small in both, whilst the Indus Delta receives a distinct character from the western element.
3. The ratio of the families, genera and species in the two areas is about the same.
4. When better known, the flora of the Indus delta will prove numerically richer in species and genera than that of the Sunderbans.

For these differences the authors, after instituting a comparison between the two deltas from the various points of view, have the following explanation to offer :—

'It is the plant-geographical position of the two deltas that has produced the two vastly different floras. A glance at the map will at once show the great possibilities of immigration and transport by river and sea, and these possibilities are more numerous in the East than they are in the West. If, in spite of these advantages of the Sunderbans, its flora is comparatively poor, we can find an explanation only in the fact that the soil and water conditions of the delta have not been favourable to most immigrants that must have tried, in the course of thousands and perhaps millions of years, to force an entrance into the savannahs and swamps of the Sunderbans. It would be a fascinating study to find out what seeds of plants have been carried down by the rivers and washed ashore by the sea without ever awakening to new life. It would certainly make a valuable contribution to plant-geography and ecology.'

Besides the numerous tables and graphs that accompany the text, the book also contains a number of photographs spread over the whole text. On the whole the plates reproducing the latter are not satisfactory. At the end there is a series of 8 plates figuring the physiological anatomy of some of the plants.

The senior author, Father Blatter, who is already known for his solid contributions to Indian Botany and who is a recognized authority on plant-geographical studies, is responsible for the whole text, excepting that on Physiological anatomy which is by Mr. Sabnis. The specimens were named by the latter and Mr. McCann. The last named is responsible also for the photographs.

The get up on the whole is satisfactory. But sufficient care has not been bestowed on correcting the text. There are a number of topographical mistakes and sometimes the reference to pages is faulty inasmuch as it still follows that of the original articles instead of conforming to the present numbering of the

book. For instance 'p. 35' in the first line after 'Additamentum' on page 38 should have been 'p. 5'. There was also no necessity for retaining 'Part II' on page 17. No index is given. This is a very serious drawback.

For the rest the book is a valuable and serious study likely to stimulate work on the various problems indicated or suggested therein.

N. K. T.

6. DIE ZYTOLOGIE DER BLUTENPFLANZEN. By P. N. Schürhoff. Pp. xv + 792. Stuttgart, Ferdinad Enke, 1926. Price 54 Marks (Illustrated).

In recent years increasing attention that has been paid to the study of the science of genetics has stimulated cytological research as never before. The result has been the clearer recognition of the fact that cytological features have a great bearing on taxonomic questions, and these have often been successfully exploited in disentangling some obscure phylogenetic relationships. A comprehensive treatment of this aspect of the life-histories of Gymnosperms and Angiosperms, representing as they do the two most dominant groups of the present day flora, was therefore most needed. *The Morphology of Angiosperms*, with its companion volume, *The Morphology of Gymnosperms*, by Coulter and Chamberlain, included the treatment of the whole field of morphology, and only incidentally touched upon cytological features. Besides the former has never been revised since its publication nearly 25 years ago, and the latter is behind time by more than a decade, while most of the research work on cytology—and practically the whole of it relating to genetics—has been done since.

The present work is, therefore, doubly welcome not only as supplying a long-felt want but also as being from the hands of one whose contributions to the subject, specially on the gametophyte generation of angiosperms, have been most extensive, and who is, therefore, competent and a recognized authority to write with first-hand knowledge on the subject.

The book is divided into two parts. The first treats of (1) the general cytology dealing with nuclear phenomena in all their bearing. It also includes a discussion on the normal and experimental physiology of the nucleus wherein a detailed treatment of the influence of various physical and chemical factors, viz., temperature, pressure, light and chemicals is given ; and (2) the general account of the X-generation in which, beginning with the development of the male and the female gametophytes of Gymnosperms and Angiosperms, the whole sequence of phenomena leading up to the fertilization and formation of the endosperm are dealt with in complete detail. Finally there is a discussion on the bearing that cytology has on systematics both from the point of view of chromosome numbers as well as from that of the male and the female gametophytes.

While dealing with these topics, the author also expresses his interesting views on such questions as the relation of amitosis to mitosis, the occasional occurrence of 3-fold spindle in endosperm and the evolution of the embryosac of angiosperms. It will be beyond the object of this review to deal with them here, and the reader is therefore referred to the original work. It may, however, be mentioned that, while dealing with the nucler phenomena, the author emphatically repudiates the suggestion of the suspicion which is often entertained that the 'fixed' and stained preparations may represent artificial products and says 'the researches on the living nucleus have not widened our knowledge but in many cases have merely confirmed the observations made on the stained material.' Coming as it does from a person of such recognized authority, this statement is of very special significance.

The second part treats of the special cytology of the different classes, families and species of the seed-plants, including even the known fossil representatives, and includes a detailed account of all the known researches giving chromosome numbers of the individual families and species in cases they have already been recorded. While dealing with these the author particularly emphasizes those features which may be of use in any discussion of phylogeny. Besides, he also discusses in the light of haploid development the relationship of the Monocotyledons to the Dicotyledons and of the Gymnosperms to the Angiosperms.

The book is thus a compendium of most useful information on the subject of the cytology of 'Flowering Plants', and not merely a text-book, as the author very modestly styles it in the preface. The information is also presented in such a systematized and masterly manner, that it may be confidently asserted that the investigator who may eagerly turn to its pages will never be disappointed.

The text is plentifully illustrated and there is copious bibliography for the use of those who may like to go to the original sources. After consulting the work one only wishes that publications like these were also available in English for the benefit of those who cannot take advantage of the German language.

N. K. T.

7 A TREATISE ON THE BRITISH FRESH-WATER ALGÆ. By West, G.S., and Fritsch, F.E. Pp. xviii and 534, Cambridge, at the University Press, 1927. Price 21*s*. net.

This is a new and revised edition, mostly rewritten, of the work, long since out of print, of that brilliant British algologist, the late Mr. G. S. West.

It is scarcely surprising that with the intensive studies carried on these organisms since the first edition was published and the consequently greatly increased knowledge of these and related organisms, it has been necessary to make very extensive changes in order to bring it up to date. The most outstanding feature of the present work is the inclusion of the pigmented Flagellates, in accordance with the increasingly greater recognition of the phylogenetic relationship between these and the algæ, which is associated with the names of Bohlin and Luther in Sweden and F. F. Blackman in England. We may, therefore, now take it that the flagellate ancestry of the algæ is an established fact.

Another consequence of these extensive studies is the inclusion of as many as 62 new genera that were unknown when the first edition was published. Besides these, amongst the most noteworthy changes are the regrouping of the Siphonales and the Ulotrichales, on account of the removal of the Chætophoraceæ and the Sphæropleaceæ from the former to the latter. In doing this more emphasis has been laid on the nature of the chloroplast, the multinucleate condition being given a subordinate position. This change has been commended as desirable, though of course there are others who may not agree as to its propriety. Another change is the separation of the Chætophorales and the Ulotrichales on account of their quite distinct somatic organization.

The subject matter, on the whole, follows the same general plan of arrangement as in the earlier edition. The first 50 pages are devoted to Introduction, in which topics of general interest are dealt with, and these, together with the introductory portion preceding each group, form a valuable account of these plants even to the elementary students. There are valuable hints on the collection and preservation, and notes relating to the distribution and ecology specially useful to the students of the British Isles. The remaining portion is dealt with under 11 classes of which the Phæophyceæ are omitted as not represented in Fresh-waters of Britain. An interesting feature of the book is the emphasis on the presence of the parallel types of organization to be found n each of the classes dealt with, a subject dealt elsewhere too by the author.

The book is profusely illustrated, there being a figure for every genus represented in the British Fresh-water algal Flora, and in addition several species of the larger genera are also included. This, in addition to the keys, gives added value to the publication. Owing to the inclusion of a large amount of extra matter within the limits of the original volume, the text has had to be condensed and many abbreviations introduced. A few printing mistakes have crept in (viz. Fig. 73 H. I. on page 37 ought to be P. 71 Fig. H. & I.). But otherwise the book is excellently done, is full of the most useful information based on the personal study of one, who perhaps more than any other in the British Isles to-day is an authority on these organisms. The large amount of general information and the clear illustrations of a group of organisms which are world-wide in distribution make this book considerably useful to students and experts beyond the confines of the British Isles.

N. K. T.

8. THE FLOWERING PLANTS OF MADRAS CITY AND ITS IMMEDIATE NEIGHBOURHOOD. By P. V. Mayuranathan, B.A., Bot. Assistant, Madras Museum. Bulletin of the Madras Government Museum, New Series Natural History Section, vol. II, 4to, pp. 1-345, pls. 1-38. Government Press, Madras, 1929. Price (paper covers) Rs. 8.

We heartily welcome this *Flora.* It has, in the author's own words, 'been prepared with the object of helping the non-specialist to identify the flowering plants of the neighbourhood of Madras City.' Dr. Gravely is right when he says in the preface: 'A real interest in plants can never become general until one observer can discuss what he sees with another; for which correct naming is the only possible basis. Particularly is this the case with those who try to foster in children their natural interest in life and beauty, an interest which often leads them to a love of trees and flowers.'

It was an excellent idea to bring out this very localized *Flora* and it is to be regretted that similar books do not exist for other big towns of India. If we consider that towns are the centres of education in general and especially of Gollege education, and that we find in every big place a considerable number of persons interested in natural history, we can only wonder why such books have not been written before. If a citizen in the town of Bombay wishes to know the name of a road-side tree or of a little herb growing on a garden path, he will have to consult the two big volumes of Cooke and perhaps the seven volumes of Hooker's *Flora of British India*, and it is more than likely that even then his efforts will not be crowned with success. But if we were in possession of a local *Flora of Bombay*, the naming of plants would be greatly facilitated, and even College students might be induced to take some interest in identifying plants.

The author mentions the difficulty that has been experienced in deciding what cultivated or introduced plants should be included in this book. He arrived at this conclusion: 'All self-seeding plants have been included in the keys together with a few of the commonest and best known cultivated plants. Some additional introduced plants are included among the descriptions but,.not in the keys. Most, however, have had to be omitted altogether.' This, of course, is not satisfactory, and those who have to use the book will often be at a loss how to find the name of a plant. To a novice in botany every plant is unknown and he is not able to say *a priori* whether a plant is indigenous or introduced. I must confess I would have felt the same difficulty if I had been in the author's place. The only solution would be to include in such a work all the plants that are being found in a given area and to give keys for all; but this would very likely more than double the number of species to be described.

As to synonyms, all have been omitted except in a few cases where names have been given different from those adopted in the *Flora of British India.* Short references to some works containing illustrations would have made the volume more helpful, especially as the literature on Madras plants is so rich in illustrated publications.

An attempt has been made to bring the names of the species up-to-date, but much more could have been done.

If I mention in the following a number of cases, it is not my intention to detract from the value of the volume under review. Everybody will agree that we have to keep pace with well-founded changes in nomenclature if we do not want to lag behind European botanists and European literature. I do not wish to imply that the changes I propose are final or even always correct. I keep myself open to criticism and am grateful for corrections. It is regrettable that we do not help each other more in this direction.

Page 25. *Nelumbium speciosum* Willd. has to be replaced by *Nelumbo nucifera* Gærtn. Fruct. I (1788) 73, t. 19, f. 2.

Page 27. *Gynandropsis pentaphylla* DC. is, according to Merrill, identical with *Cleome gynandra* Linn. Sp. Pl. II (1753) 671 and should, therefore, be named *Gynandropsis gynandra* Merrill [see Enum. Philip. Pl. II (1923) 209].

Page 28. *Cratæva religiosa* Forst. (should be Forst. f.) is the Polynesian plant which, according to Craib, is totally different from the Asiatic plant. This should be called *Cratæva nurvala* Ham. in Trans. Linn. Soc. XV (1827) 121. I have made the same mistake in my revision of the *Flora of the Bombay Presidency.*

Page 28. *Cadaba indica* Lamk. should be reduced to *Cadaba farinosa*

Forsk. Fl. Aeg.-Arab. (1775) 68. If the character of 4 stamens were constant, it might form a good specific character, but flowers with 4 and 5 stamens may be observed on the same twig of *C. indica.*

Page 29. *Capparis brevispina* DC. The author gives *Capparis zeylanica* Wall. as synonym. Where did Wallich describe this species? The only correct synonym seems to be *C. zeylanica* Hook. f. & Thoms. in Hooker f. Fl. Brit. Ind. i, 174 (*non* Linn.).

Page 47. *Eriodendron pentandrum* Kurz should be called *Ceiba pentandra* Gaertn. Fruct. ii (1791) 244, t. 133.

Page 50. *Waltheria indica* Linn. should be called *W. americana* Linn. Sp. Pl. (1753) 673.

Page 53. *Triumfetta rhomboidea* Jacq. should be called *T. Bartramia* Linn. Syst. ed. 10 (1759) 1044; Fawcett & Rendle in Journ. Bot. lix, 224. *Bartramia indica* Linn. Sp. Pl. i (1753) 389. We cannot use the earliest trivial name because *T. indica* Lamk. is not well known.

Page 54. *Corchorus acutangulus* Lamk. should be called *C. æstuans* Linn. Syst. ed. 10 (1759) 1079; Fawcett & Rendle in Journ. Bot. lix, 225.

Page 59. *Murraya Kiöngii.* Change into *Königii.*

Page 59. *Murraya exotica* Linn. should be called *M. paniculata* Jack in Malay Misc. i, No. 5 (1820) 31.—*Chalcas paniculata* Linn. Mant. i (1767) 68.

Page 68. *Cayratia* Juss. I think Craib is right in calling this genus *Columella* Lour.

Page 69. *Cayratia carnosa* Ggnep. would accordingly have to cede to *Columella trifolia* Merrill in Philipp. Journ. Sc. Bot. xi (1916) 134.

Page 69. *Cayratia pedata* Juss. The authority for this name is Gagnepain in H. Lec. Not. Syst. i (1911) 346.—The species in accordance with the previous entry should be named *Columella pedata* Lour. Fl. Cochinch (1790) 85.

Page 72. *Odina* Roxb. should be replaced by *Lannea* A. Rich., and *Odina Wodier* by *Lannea grandis* Engl. [*Haberlia grandis* Dennst. Schlüss. Hort. Malab. (1818) 30].

Page 78. *Pseudarthria viscida* Wt. & Arn.—It seems to me that Haines [Bot. Bihar & Orissa, pt. iii (1922) 260] has given sufficient reasons for including this species under *Desmodium* under the name of *Desmodium viscidum* DC.

Page 82. *Pongamia glabra* Vent.—Merrill in his Interpretation of Rumphius' Herbarium considers that *P. glabra* is the *Cytisus pinnatus* Linn. and that, consequently, the specific name *pinnata* has priority. It should, therefore, be called *Pongamia pinnata* Merrill.

Page 92. *Indigofera aspalathoides* Vahl. Spell *aspalthoides.*

Page 112. *Bryophyllum pinnatum* Kurz. Perrier de la Bathie who for years has made a special study of the *Crassulaceæ* of Madagascar puts *Bryophyllum* under *Kalanchœ* receiving the old name of the above species: *Kalanchoe pinnata* Pers. Syn. Pl. i (1805) 446. [See Archives de Botanique Tome ii (1928) 20]

Page 146 *Randia dumatorum.* Spell *dumetorum.*

Page 173. *Nerium odorum* Soland should be called *Nerium indicum* Mill. Gard. Dict. ed. viii, no. 2.

Page 189. *Heliotropium zeylanicum* Lamk. should be called *Heliotropium subulatum* Hochst. *ex* Martelli Fl. Bogos. (1886) 59.

Page 199. The authority for *Merremia ægyptia* is not T. Cooke, but Gamble, Flora Pres. Madras (1923) 928. Cooke retained *Merremia pentaphylla* Hallier f. in spite of his note in vol. ii, 240 of his Fl. Bombay.

Page 237. *Bougainvillea.* Spell *Buginvillæa* (see Kew Bull. 1928, 340).

Page 245. *Alternanthera triandra* Lamk. should be called *Alternanthera sessilis* (Linn.) R. Br. Cf. *Gomphrena sessilis* Linn. Sp. Pl. 225.

Page 262. *Hemicyclia* Wt. & Arn. Pax & Hoffmann have, apparentyl with good reasons, united this genus with *Drypetes* Vahl Eclog. Amer. III (1810) 49. [See Engler's Pflanzenr. iv. 147. xv (1922) 227-29.]

Page 262. *Hemicyclia sepiaria* Wt. & Arn. should be called in agreement with foregoing lines: *Drypetes sepiaria* (Wt. & Arn.) Pax & K. Hoffm. l.c. 271.

Page 272. *Ficus gibbosa* Blume var. *parasitica* Koen.—The authority for the variety is King Sp. Fic. (1888) 6, t. 2b, Fig. B., not Koenig. Why should this species not be called *Ficus parasitica* Koenig?

Page 300. *Tiphonium.* Spell *Typhonium.*

Page 308. *Cyperus pumilus* Linn. This species is identical with *Pycreus nitens* Nees on p. 309 and for those who wish to retain the genus *Pycreus*, it should be called *Pycreus pumilus* Turrill in Kew Bull. (1922) 124. Of the Turrill gives the following synonymy: *Cyperus pumilus* Linn. Amoen. Acad. IV (1788) 302 *et* Sp. Pl. ed. 2, 69.—*Cyyperus nitens* Retz., Obs V (1789) 13?—*Cyperus pulvinatus* Nees et Meyen in Wight Contrib. (1834) 74.—*Pycreus pulvinatus* Nees in Linnaea IX (1834) 283.—*Pycreus nitens* Nees l. c.—C. B. Clarke in Fl. Brit. India VI, 591.

A word has to be said about the illustrations. The text is accompanied by 38 plates, each figuring 4-7 species. They are not all of equal quality, but nearly all will be what they are intended to be, a help in identification work and they may be recommended even to those who study Indian plants in other parts of India.

It would have been a great advantage if the book had been brought out in smaller size. What the volume offers regarding matter and treatment is just what you would like to have with you when you go out for a ramble in town or neighbourhood. Let us hope that a second edition will soon be required and that the authorities, who have done so much to bring out the first, will see their way of offering the public a handy *Pocket-Flora.*

E. B.

9. A MONOGRAPH OF THE GENUS ARISTIDA, vol. I. J. Th. Henrard. In Mededeelingen van's Rijks Herbarium, Leiden. No. 58 (1929).

Henrard's preliminary work: 'A critical Revision of the genus Aristida', was reviewed in these pages some time ago. That 'Revision' gave all the species known up to now with the exact copies of the authentic descriptions. To these were added illustrations of the spikelet-characters drawn from type specimens wherever possible. Though extremely useful and in many cases necessary for the systematist, the monograph under review is still more indispensable, as it shows what species have been finally adopted.

In his treatment of the subject Henrard does not follow the ordinary type of monographs. His book is in the first place a practical handbook to the knowledge of this very difficult genus. Excellent artificial keys lead up first to the sections of the genus and then directly to the species. 'I was obliged,' the author says, 'to omit in this work all the data already given in the Revision and to take into consideration that, with this monograph before us, we must, after being somewhat familiar with the genus and the different characters, without great difficulties, get a clear idea of it and with the keys before us find the name of a specimen belonging to our genus.' We quite understand that a number of details given in the 'Revision', could not be repeated in the monograph, but we miss very much a concise reference to the synonyms given in the 'Revision', or at least a reference to the pages in the 'Revision' where the synonyms might be found. This is, however, only the first volume and we should not criticize this point without having seen the second.

No attempt has been made to bring allied species together into groups because, as the author explains, such groups are difficult to limit and because it is not easy to explain the habit of such groups in a key.

After having studied about 15,000 specimens, the writer complains that no attention had been paid by taxonomists to the numerous intermediate forms and that no hybrids had ever been observed or indicated in the literature of the genus. He is convinced that these hybrids are much more numerous than the various herbaria seem to reveal. What he recommends to agrostologists is the study of the grasses in the field and by cultivation. It is only by the latter method that we shall learn more about the constancy of different characters.

In the general part of the volume the author gives an interesting history of the nomenclature and system of the genus *Aristida.* He then discusses the position of the genus in the system of the Gramineae and indicates the characters to be used for the limitation of the species. A highly interesting chapter is added on the geographical distribution of the sections and species.

All the illustrations of the 'Revision' have been repeated in this volume which is one of the most ideal monographs in the history of botanical literature.

E. B.

10. PLANT BIOLOGY.—By H. Godwin, M.A., Ph.D. An Outline of the Principles underlying Plant Activity and Structure. Cambridge, at the University Press. 1930. Price 8 *s.* 6 *d.* net.

The book under review is based on elementary lectures given to first year medical students and designed primarily for their use but, at the same time, it is intended to have a wide utilization by other biological students of similar status as e. g. in the higher forms of those schools in which biology is taught and in the introductory classes of training colleges. The author wishes to make good a deficiency which he, as a member of the Cambridge Botany School, has repeatedly noted, viz. 'that too often students of botany not only come up to the University, but pass through its botanical courses with far too little appreciation of the general biological significance of the subjects with which they deal.'

What the writer complains of is exactly the same that every botany teacher in India has in his mind when he sees how the medical faculties at our universities show a 'natural and strong tendency to cut down preliminary introductory study to a minimum, and to excise all matter save that with direct and obvious application to later and more specialized medical work.' The natural consequence is that we are utilizing in preliminary science courses matter as closely linked with later work as possible, and discard things which may be part of the traditional teaching of the subject but which the medical student is not likely to meet with again. It is for this reason that the author has largely designed his text-book to comprise material or principles which must later be more fully developed by the student. He has paid special attention to the simpler aspects of physiology of the green plant and of the bacteria and fungi (Chapters I, VII and VIII). By dealing with the chemistry of simple organic substances and their occurrence in the plant in a colloidal state, he is creating the general foundation for later work on animal physiology and illustrates the significance of general physiological treatment in the widest possible way (Chapters II, III, V and VI). What we usually find in books of this kind, viz. the study of the flowering plant, its reproduction and many details of morphology and anatomy, have been practically omitted and only a few facts have been described which are necessary for understanding the outlines of the more important physiological processes in the plant. Only a few plant-types have been included (Chapters IX, X, XI and XII) which will help to understand the specialization and differentiation of the land plant as the end product of an evolutionary series of green plant organisms, and which, in addition, will illustrate 'such wide principles as differentiation of tissues and organs, specialisation and division of labour, the origin of sex and of a mortal plant body.' No mention is made of alternation of generations. Everybody will agree with the author that the gain is not worth the considerable time necessary to teach it, unless the principle is later to be applied to the most complex plant types.

As this book has not been written for students of less than sixteen or seventeen years of age, it is just the right guide for our Indian students who possess some elementary knowledge of physics and chemistry. They will find the writing self-explanatory or can easily find the necessary explanation by reference to a text-book of physics or chemistry.

But even advanced students will read or rather study this book with profit. They will always find it stimulating as it is full of practical hints on method and remarks of a more general nature which cannot help forming the minds of the future research workers. As an instance I quote the last lines of the book:—

'Modern work on the stomata and the modern views about them well illustrate the present tendency of all physiologists to concern themselves with what a structure does, and the mechanism by which it takes effect, rather than to leave the situation with an unsatisfactory guess that the structure is present "in order to carry out some process" or "for some particular purpose" or "to serve some particular function." These latter can never be more than mere guesses, for the plant cannot be said to create structures *purposefully* at all, and progress can best come by examining physiological phenomena in physico-chemical terms, and by determining what things organs actually *do* and *how* they do them. The nature of the origin and persistence of organs is a matter to be considered closely in studies of heredity and evolution, and not to be guessed at prematurely.'

E. B.

MISCELLANEOUS NOTES

I.—THE ALARM CALL OF LANGOORS

With reference to Major Logan-Home's note on page 971 of Vol. xxxiii, No. 4, I would suggest that the reason why the langoors he mentions did not give the alarm cry for the wounded leopard was that it crawled slowly and painfully through grass and undergrowth in such a way that the langoors did not see it. Perhaps their attention was focussed in some other direction, or there may have been many thick branches between them and the ground. It is to be remembered that, as far as we know, langoors rely upon eyesight only for detecting leopards and tigers, and a whole menagerie might easily pass beneath them without causing a single alarm cry provided the menagerie kept out of sight. My original contention, to which Colonel Burton took exception, was that, if langoors *continued* their alarm cry for any considerable time, it nearly always meant the presence of a tiger or leopard, and I have verified the accuracy of this statement literally hundreds of times. I certainly did *not* claim that if langoors did not call, therefore it could be assumed that no tiger or leopard was present. After all, even langoors are caught napping sometimes—*vide* Major Logan-Home's note—and, if that were not the case, leopards in particular, since they eat a good many monkeys, would very often go hungry.

I have been studying natural history far too long not to realize the folly of making dogmatic statements as to what wild animals will or will not do under varying conditions; but, so far as the foot-hill forests of Garhwal are concerned, my experience over 8 years (most of which have been spent actually *inside* jungles teeming with leopards and tigers) has been that the continued alarm cry of a langoor is the most reliable sign available of the presence of a tiger or a leopard. I do not, and never did, claim that the langoor, or any other living creature, is infallible. Colonel Burton's argument about langoors calling for domestic dogs is really beside the point, since one knows where one's dogs are, and, if one values them, one does not let them run about all over the place in jungles infested by leopards. In any case, I personally have never found any difficulty in differentiating between alarm cries given for dogs and those for the much more serious danger of leopards.

DEHRA DUN,
December 10, 1929.

F. W. CHAMPION,
I.F.S.

II.—TIGER OR PANTHER?

Mr. Limouzin's specimen

(With two plates)

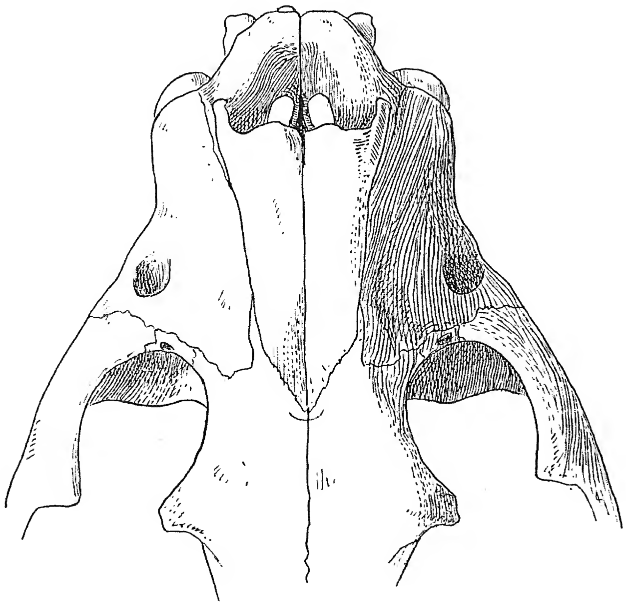
In writing this paper to settle finally, so far as I personally am concerned, the debated question that has arisen over the determination of what has been called the record Indian panther shot near Ootacamund by Mr. E. E. Limouzin, I need not repeat the history of the animal, or animals, as originally told by Mr. S. H. Prater on information received from Mr. Van Ingen, the younger, (*Journ. Bombay Nat. Hist. Soc.,* xxvii, pp. 933-934, 1921) and subsequently and more fully by Mr. Limouzin himself in the May issue of the current volume of this *Journal* (pp. 699-700). I am only concerned with the skull.

This skull was sent to the Bombay Natural History Society for determination, not by Mr. Limouzin who never doubted it was the skull of the panther he saw and shot at, but Mr. Van Ingen, the younger, who apparently in defiance of the matured opinion of his more experienced uncle, had evidently very grave doubts on the point. Mr. Prater, however, pronounced it to be undoubtedly the skull of an adult panther and a record in length so far as India is concerned. Fortunately he published a photograph of a side view of the skull together with photographs of the skull of an Indian panther, of a tiger and of a lion. A glance at this photograph was sufficient to tell me that Mr. Limouzin's skull was a tiger's, not a panther's; and this I stated, not as a suggestion or opinion, but as an undoubted fact, in my paper on tigers in the May number of this Journal (p. 518).

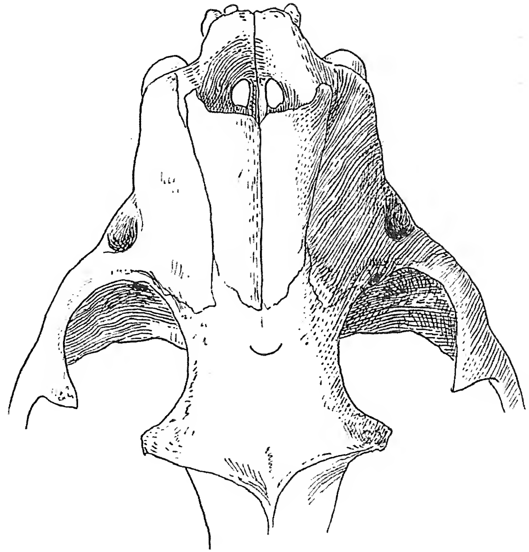
This decision, based solely upon the scanty information regarding the skull and the rather obscure photograph of it published in the Journal eight years ago, was very naturally not accepted by Mr. Limouzin nor by Mr. Prater who had the skull in his hands and presumably a good collection of tigers' and panthers' skulls in the Museum at Bombay wherewith to compare it; and it was a letter from Mr. Prater to Mr. Limouzin telling him my decision before it was published and asking for confirmation and, if possible, further particulars of his story of the shooting of the panther, that produced Mr. Limouzin's account above referred to; and also induced him on his return to England in the spring to open communications with me.

In response to my offer to examine the skull, he not only very kindly brought it to the Natural History Museum in October but left it in my charge for more than a week, so that I was able to take the measurements recorded below and make the sketches herewith published. And I may here state that the skull is most certainly a tiger's. This I say without the least fear of contradiction from anyone acquainted with the skulls of tigers and panthers and accustomed to handling them. The determination does not admit of a doubt.

To be more precise, the skull is the skull of a youngish tigress. No doubt she was adult in the sense of being sexually mature, but



A.



B.

A. Facial portion of skull of Mr. Limouzin's tigress. Half natural size.

B. The same of large male panther.

she was apparently not quite full-sized, judging from the distinctness of the open sutures of the skull, the shortness of the occipital crest and the separation of the temporal ridges as far back as a point behind the middle of the parietals.

My original suggestion that the skull was probably a tiger's rather than a tigress's was due to an error by Mr. Prater in recording its length, which quite misled me. He gave the basal length as 11·3 inches, which, as I stated, would indicate a total length of something like 13 inches,—very long for a tigress. As a matter of fact I make the *total* length, that is to say the length from the tip of the occipital crest to the edge of the premaxilla above the incisor teeth, only 11·2 inches, and the *basal* length, that is to say the length from the incisive border to the lower edge of the occipital foramen, 9·6 inches. The skull thus turns out to be nearly two inches shorter than stated by Mr. Prater. But that is a relatively unimportant point, affecting only the question of its sex, not of its species.

In actual length there is not always much difference between large skulls of male panthers, especially African, and smallish skulls of Indian tigresses; but the tigress's skull can be distinguished at a glance by its greater height, and general massiveness, notably in the width of the jaws, and in the much greater size of the teeth. In its *tout ensemble* it is quite unmistakable; and Mr. Limouzin's skull is a perfectly typical tigress's, with nothing at all remarkable about it. It has the large teeth, the massive muzzle, the long nasals, the broad mesopterygoid fossa etc. of the tiger, and even the well-developed additional tubercle on the upper carnassial which is never more than just indicated in adult panthers' skulls.

If the dimensions of this skull, given in the subjoined table, be compared with those of the skulls of tigresses published in my paper on Tigers, on p. 517 of the May issue of this *Journal,* very close agreement between them will be revealed. For the sake of comparison I have included in the table the measurements of the skull of a full-grown tigress, a little older than Mr. Limouzin's specimen. This tigress came from the Dhar State, Central India, and was very kindly presented to the Natural History Museum by Mr. R. K. M. Battye in response to my appeal for specimens published in the last number of this *Journal.*

One or two little points connected with the measurements of these two skulls are interesting. It will be noticed that in basal and condylo-basal length Mr. Limouzin's specimen is distinctly longer, yet it is shorter in the total length than Mr. Battye's. The superiority of the latter in total length, as in zygomatic width, is simply a question of age. If Mr. Limouzin's tigress had been permitted to live another year or so, her skull would have surpassed Mr. Battye's in total length by the backward growth of the occipital crest.

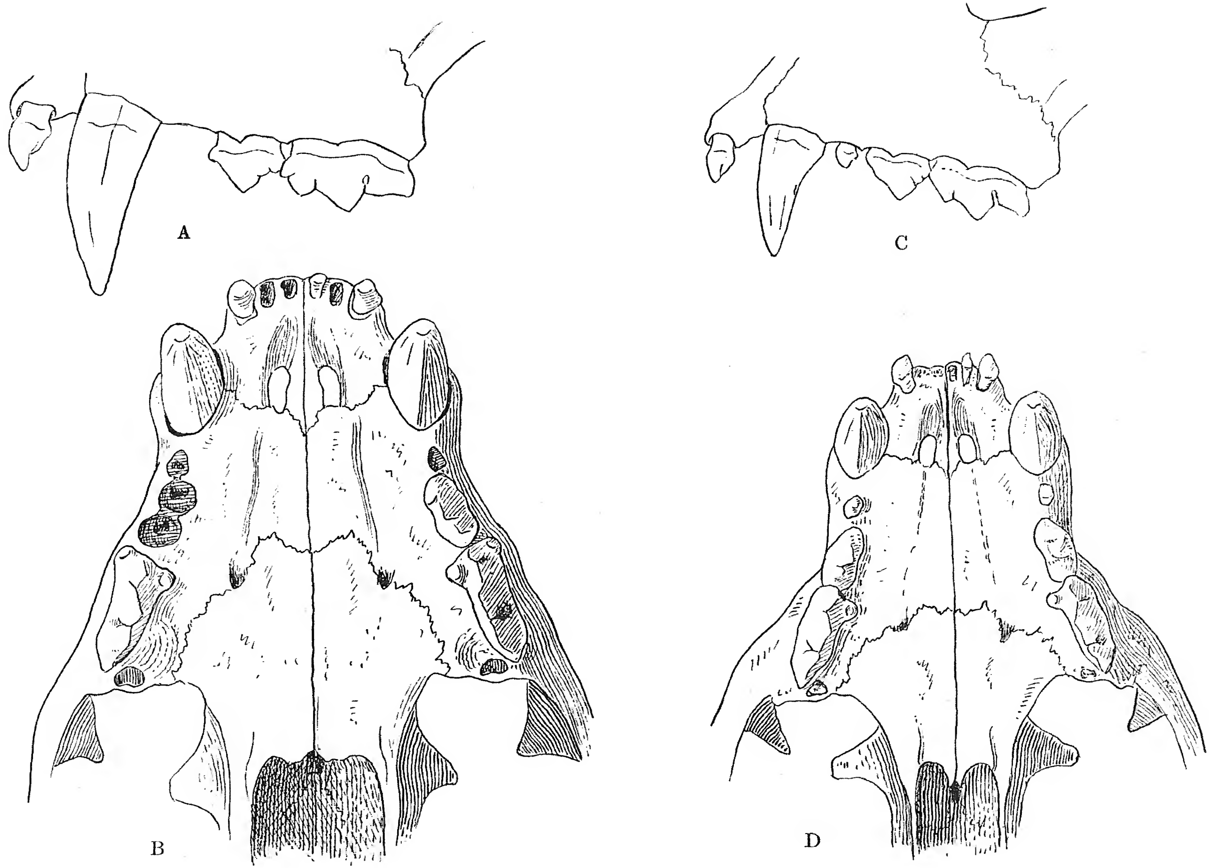
The table also contains the measurements of the skulls of two fully adult male panthers. One, from the Welle River in the Upper Congo, obtained by Sir Alfred Sharp, is the largest panther's skull in the Natural History Museum. The other, from Kashmir, is the longest Indian panther's skull in that institution.

The measurements speak for themselves but they become much more impressive if translated from figures into lines with a compass, pencil and a foot-rule.

—	Tigress		Male Panther	
	Ootacamund (E. E. Limouzin)	Dhar State (K. R. Battye)	Upper Congo (Sir A. Sharp)	Kashmir (Mrs. Entwisle)
Total length ...	11·2 in.	11·3 in.	11 in.	9·8 in.
Cond. bas. lg. ...	10·3+ ,,	10 + ,,	9·7 ,,	8·7 ,,
Basal lg. ...	9·6 ,,	9·2 ,,	9·1 ,,	8·2 ,,
Zygom. width ...	7·4 ,,	7·7− ,,	6·4 ,,	6·3 ,,
Cranial width ...	3·2 ,,	3 ,,	2·9 ,,	2·8 ,,
'Waist' width...	2·3 ,,	2·4 ,,	1·7 ,,	1·4+ ,,
Int. orb. width ...	2·1 ,,	2·4 ,,	1·9 ,,	1·5+ ,,
Muzzle width ...	3·2 ,,	3·3 ,,	2·5 ,,	2·5 ,,
Premax. width...	1·6 ,,	1·5 ,,	1·1 ,,	1 ,,
Nasals ...	3·9×1·9 ,,	4−1·9− ,,	3×1·6 ,,	2·7×1·5 ,,
Mandible lg. ...	7·8 ,,	7·6 ,,	7·2 ,,	6·5 ,,
Upper Canine ...	22 mm.	23 mm.	17+mm.	17 mm.
Upper Carn. ...	33 ,,	33 ,,	28 ,,	26 ,,
Lower Carn. ...	24 ,,	25 ,,	20 ,,	19 ,,

The measurements were taken as follows :—

Total length from tip of premaxilla to tip of occipital crest.
Cond. bas. lg. ,, ,, ,, ,, ,, edge of occipital condyle.
Basal lg. ,, ,, ,, ,, ,, ,, ,, ,, orifice.
Zygom. width across the cheek-bones.
Cranial width across the cranium at the parieto-squamosal suture.
'Waist' width across the postorbital construction.
Int. orb. width across the forehead between the eyes.
Muzzle width across the muzzle just above the socket of the canines.
Premax. width across the premaxillæ above roots of outer incisors.
Nasals. Length from median point behind to tip of process in front; width across processes in front.
Mandible from point below incisor teeth to outer end of condyle.
Canine. Width from back to front close to socket.
Upper Carn. and *Lower Carn.* Greatest length of the upper and lower carnassial teeth.



A. & B. Teeth of upper jaw and palate of Mr. Limouzin's tigress. Half natural size.

C. & D The same of a large male panther.

On Pls. I & II I have drawn to scale the upper and lower views of the fore part of the skull belonging to Mr. Limouzin and of the largest male Indian panther skull in the Natural History Museum, and a side view of the teeth of the upper jaw of the same specimens.

In conclusion I should like to express my appreciation of Mr. Limouzin's action in bringing this skull to me for examination and leaving it in my hands for description and measurement; and I am sure it is needless for me to add that from the first I have never for one moment wished to call in question his *bona fides* in the matters concerning this skull. I regret indeed that I have to reassert most positively my original decision that it is a tiger's and not a panther's skull; but into the possible explanations of his mistake it would be quite out of place for me to enter.

BRITISH MUSEUM (NAT. HIST.), R. I. POCOCK.

LONDON, *December, 1929.*

III.—MR. LIMOUZIN'S SPECIMEN

I am glad that Mr. Pocock has been able to arrive at his conclusion as regards the identity of the skull obtained by Mr. Limouzin from an actual examination of the specimen which was submitted to him by Mr. Limouzin at my request.

There are one or two points which I should like to comment on. From the context of Mr. Pocock's note it would appear that the statement by Mr. Limouzin in regard to the finding of strips of panther skin with the skeleton was made in response to my request asking for confirmation and further details. Mr. Limouzin made the same statement to Mr. E. Van Ingen when he originally forwarded the skull and skeleton to him for identification. In sending the skull to the Society Mr. E. Van Ingen wrote 'The skeleton and skull remained with strips of skin and Mr. Limouzin who examined what he found of the latter is positive that the animal is a panther' (*vide* my original note, *Journ. Bomb. Nat. Hist. Soc.*, Vol. xxvii, p. 933). I had therefore no hesitation in accepting the evidence of the man who saw, shot and subsequently examined portions of the skin of the animal. Blanford in his Mammalia gives no specific characters for distinguishing between the skulls of panthers and tigers. He however states that when a leopard's skull is placed on a flat surface the hind part of the skull almost always touches the surface. This was the condition in regard to the skull obtained by Mr. Limouzin. It has been shown however by Mr. Pocock that owing to variation in the degree of the convexity of the lower surface a similar condition may occasionally be observed in the skulls of tigers. The skulls of panthers and tigers are so alike, there is so much intergredation between them in all essential characters, that size is the main character by which they are distinguishable. This was pointed out as early as 1867 by Dr. J. E. Gray who examined a series of skulls of *Felidae* in the British Museum. Dr. Gray wrote 'the skulls of the lion, the tiger, the

leopard and the jaguar are nearly similar in form and teeth and chiefly to be distinguished by their size and other slight characters.' (*Proc. Zool. Soc. Lond.*, 1867, p. 258.) Now in examining the skull submitted by Mr. Van Ingen I was immediately struck with its comparatively enormous proportions. With Mr. Limouzin's evidence before me I believed that I was dealing not with a large panther but with one of abnormal development. In support of this belief I had the notes submitted to me along with the skull by Mr. E. Van Ingen. His notes provide the evidence of different people who comment on the abnormal development of this animal. (*Vide* my original note, *loc. cit.*)

First we have Mr. Limouzin's statement to Mr. Van Ingen

> 'He (Mr. Limouzin) tells me that he had seen this panther on several occasions and examined it through glasses and that its *head* and *forequarters* seemed enormous while the body and hind quarters seemed to dwindle away.'

In his description of the shooting of the animal Mr. Limouzin wrote :—

> 'Before I fired at the panther I was very much struck with the extraordinary size of the *head and shoulders*.'

Then we have Col. W. Ward's statement. Mr. Van Ingen wrote :—

> 'Col. W. tells me that he had seen a panther a few miles from "Dunsdali" (Mr. Limouzin's estate), he described the *head, chest and forearms* as enormous. It was standing on a rock 20 yards away looking down at him, Col. W. who has shot many panthers claimed it to be the largest he had ever seen. He quite believes the animal of Mr. Limouzin to be the one seen by him.'

As regards the dimensions of the skull it is regretted that through an error the 'entire length' of the skull was recorded as the 'basal length' in my original note.

BOMBAY NATURAL HISTORY SOCIETY, S. H. PRATER.

January 15, 1930.

IV.—MR. POCOCK'S ARTICLE ON 'TIGERS'

Everyone will have read Mr. Pocock's article with great interest and we members are indebted to him for enlightening us with the world wide knowledge which can only be acquired at a head quarters like the London Zoo and which is largely denied to the Field Naturalist.

It is gratifying to see that Mr. Pocock has considered my views on certain points worthy of notice and I find that we are in general agreement although in questions of detail, as might be expected, some differences emerge. In what follows I have attempted as far as possible to effect a reconciliation of these views but I regret that in all cases I have not been able to do so.

Casting of Coat.

In referring to this subject Mr. Pocock is careful to avoid committing himself to the habit of Indian Tigers and relies on a quotation from a Major Alexander. He does tell us however that no marked moult takes place amongst the captive animals at the London Zoo. This statement is final and conclusive: but Major Alexander is grievously in error in stating that the Indian Tiger does not moult and the statement is sufficiently astonishing as to make one accept his other evidence with a certain amount of hesitancy. I feel confident in securing the backing of all experienced shikaris when I state that the tiger rapidly sheds his winter coat and that the skin of an animal shot in the end of January cannot be compared with a skin killed in the end of April. Also that in March much of the hair is so loose and comes away so easily one can be deceived into thinking that the pegged skin has gone wrong. Compared with India the seasonal changes in London from Winter to Summer are gradual: there is no sudden onrush of hot weather reacting on the winter coat and the natural explanations is that under temperate conditions the hairs come away and are replaced so gradually as not to be noticeable.

A few words about the condition of the Manchurian tiger may be permitted. I attribute his appearance as compared with his Indian *confrère,* say during the moult, to be largely mechanical and not due to any specialized moult peculiar to one race. I have two Labrador Dogs. Nature in the case of the pure original breed sometimes endows these with an undercoat of hair of a woolly nature. My bitch is thus favoured: her son is not. Both moult annually: to the last hair I believe. In the case of the son this appears to be a gradual process hardly perceptible unless one is brushing and attending to him. In the case of the bitch the dead hair stands out in lumps: apparent at 30 yards and can be grasped and pulled out in handfuls. This phenomenon is entirely due to the clinging nature of the woolly undercoat which retains the dead hairs and, but for which, these would have fallen off individually as they became detached from the skin. This mechanical action on the part of the undercoat, in my belief, explains the Manchurian tiger's appearance without precluding a similar but less apparent moult in the Indian Tiger.

Tiger Stripes.

I am dealing with 'Body' stripes only. What constitutes a stripe? It is obvious that some definition is required. In what follows I have taken a stripe to mean the black stripe which is 'initiated' on each side from the region of the back bone. In some cases the stripe is continuous: in many other cases it is disconnected or forms a loop: but these are merely detachments of the original stripe which has its origin in the dorsal region and they cannot be considered as separate stripes. To treat the matter otherwise leads to hopeless confusion and is misleading. In what follows therefore each process originating from the dorsal line is counted as one stripe and no other mark or stripe is so counted.

It is not always easy to determine exactly the number of stripes

from a photograph or a picture but applying the above method I arrive at the following results from Pocock's article. Plate I., 20 stripes. Plate II., 18. Plate D., Caucasian tiger, 24. Plate III., 19. Plate IV., 19. Plate F., Manchurian Tiger 15. Malay Tiger, 19. Plate H., 19.

I have counted the stripes on 34 tigers and tigresses from skins and photographs in my possession where these are clearly shown. As there is no difference between the sexes in this matter this point can be ignored.

Quite a number of tigers have only 15 stripes and quite a number have 19. In no case is 19 exceeded nor is there anything less than 15. The average works out at 17 stripes. It would appear therefore that any attempt at classification of the various races of tigers based on the number of stripes is based on unstable foundations save with regard to the Caucasian tiger which is undoubtedly very much more striped than any tiger I have ever seen or possess any record of, as Caucasian Tigers are none too numerous. It would be interesting to know if this excessive striping is consistent? While on the subject of stripes I may mention that the smaller animals and, especially two cubs included in the above 34 tigers, appear to be more heavily striped. I entirely disbelieve that stripes disappear with age. The impression to this effect sometimes conveyed in the case of a very old male is entirely an optical delusion due to the parting of the stripes on account of heavy muscular development.

Anyone can test this by a simple experiment. Under existing female fashions elastic tape is accessible to most. Take a fine pen and draw a series of lines across the tape as close as possible without actually merging: then sketch the tape and observe the results.

In viewing the stripes of the various tigers depicted in Mr. Pocock's article save as pointed out above, the number of stripes appears to be a variable and uncertain quantity but there aopears to be a marked tendency on the part of the stripes in Indian Tigers to split up and form eyes as compared with the general continuity of the stripes of northern varieties.

The Height of Tigers.

Mr. Pocock would limit the height of tigers at about 38″. In *Wild Animals in Central India* I have given the figures 38″ to 44″ as the expectation height of a really good male. Pocock's estimate was made as he describes from the Manchurian Tiger passing under a bar. I spent many hours watching this magnificent animal; certainly the heaviest boned tiger I have ever seen, although his height was in no way remarkable. Merely from eye memory I should doubt if he was as tall as a fine Indian Tiger the Zoo possessed at that time: in fact the only good Indian Tiger I have ever seen in the London Zoo: if my recollection is not at fault, he went by the name of 'Prince'. Now my measurements of tiger were made by pulling the two forefeet together and measuring between uprights placed at the base of the pads and at the withers.

This method might easily result in an additional inch or two being added to stature: further the height of a tiger slouching under a bar might be an inch or two less than a tiger standing up and at attention. The difference therefore is inappreciable and moreover is not material.

As the waiting list for candidates to measure live tiger is not yet full the old method of measuring dead tigers will probably continue, but in view of Pocock's figures possibly a discount of an inch or two should be allowed off the results thus obtained.

The Size of Northern Tigers.

On the relative size of Indian and Manchurian tigers it is to be gathered that Pocock somewhat reluctantly admits of the possibility of the latter being the larger of the two. Pocock rightly emphasises that I lay no claim to have any first hand knowledge of the Manchurian tiger: the only evidence I can adduce is that I have seen the pugs of a tiger and tigress in what he would call Amurland. In those days the name was not invented. They were immense. Out of the hundreds and hundreds of tiger pugs I have encountered I have only seen two that were at all comparable. One was close to the railway near Asirgarh and the other was in that very wild zemindari, Uprora, seldom visited by Europeans. Both were in the beat, both came within 60 years of death, neither were seen, and both escaped by failure to see personally that all precautions were carried out to the degree. It is through this gap that animals of this sort escape, however, that is another story, and enough to these irrelevancies. Coming now to the two tigers at the Zoo. Pocock rightly lays stress on what fine specimens they were: he mentions that the tigress measured 9 feet—a most unusual length.

Animals which find their way into zoo's or menageries are apt to be poor records of the animal in the wild state: so much depends on their previous history—how and when caught, at what age, and how treated when caught. There even appears to be much uncertainty with regard to these two individual specimens. When in Harbin, I was told there had been two captive tigers there during the Russo-Japanese war and that they had been shipped to Europe. Were these the same tigers I wonder? No one, however, can agree that animals benefit by captivity, and I am prepared to base my argument on the animals themselves as they were and as I saw them. Indian sportsmen rightly informed Pocock that they were magnificent specimens. They were more than that: the male was a heavier boned animal than I have ever seen. I might have seen tigers as long, I have certainly seen tigers higher at the shoulder but I have never seen an Indian tiger which could have lived in the same cage as our Manchurian friend, even were he given the same wild life, condition and resulting muscle. He was a giant! The tigress was only somewhat less striking.

No two tigers of this quality could be produced from India 'simultaneously'. No not in 100's of years: and never have been. Yet lo and behold! the one and only pair coming from northern Asia of this calibre. The question then resolves itself into whether this

was the result of fortuitous chance or whether it arose out of the fact that the probability of getting a big beast from northern Asia was greater than from India. Your readers must answer these questions for themselves. Personally I have no hesitation over the verdict. Such scanty information as I receive from northern Asia from time to time leads me to believe that in many parts tigers are becoming or have become extinct and are dying of starvation. The probabilities are that the larger race will suffer most and I may already be writing about past history.

With regard to distribution of this northern race it is quite conceivable that it has crossed the watershed from the Sungari River into the upper waters of the Yalu River which is practically a virgin country from the zoological point of view. Nevertheless although geographically it might be entitled to the nomenclature of the 'Korean' tiger it would not be the 'Korean' tiger as generally understood.

On page 522 of the *Journal,* Pocock compares 'good Indian tiger' to animals of 10′ 6″ and again 10′ 8″ in length. In summing up Pocock says 'From these imperfect data it may be inferred that this race of tigers is not larger, possibly it is on the average somewhat smaller than the typical Indian Race'. From this one must infer that Pocock overestimates the size of Indian tigers. Animals of this size in India are the greatest rarities, only occurring at intervals and being solitary specimens out of thousands.

Colouration of Tigers.

I think it will be generally agreed that the tendency of tigers frequenting dark or dense jungles is for themselves to be darker, but at any rate, so far as India is concerned, no such definite differentiation as Major Alexander's remarks imply, can be accepted. In point of fact the Asirgarh jungle which I know well, is of the openest nature, and in no way denser than the other jungles, which I also know, and to which Major Alexander refers as containing a lighter coloured variety of tiger. There is great variation in colour and the surrounding conditions must be vastly more marked between those apertaining in Central India and Asirgarh, before they could be, in any way, reflected on the colouration of the skin.

In point of fact the lightest tiger I ever saw, or killed, was in the Banjar Valley, Mandla district. No one would accuse Mandla as being of an 'open scrub jungle' District.

This animal, a male, had the white, woolly belly hair extending well up his ribs, very nearly half way up, where it merged from white wool into white hair and thence into a golden, brass colour. The black stripes were deep, very black and well defined.

My wife saw this tiger brought in and from our recollection, we consider that over one-third of the skin must have been white. Unfortunately, I cannot recollect to whom I presented it so I am unable to verify this impression by actual measurement, but these remarks, may possibly catch the eye of the person to whom I gave it.

I mention this tiger as a special case but I have shot dark and

light tigers all over the Central Provinces and there is no possible anticipation as to what type of skin one's hunt is likely to produce and I believe this to be generally true all over India proper.

ELGIN, SCOTLAND, A. A. DUNBAR BRANDER.

November, 1929.

V.—THE SIZE AND MARKINGS OF INDIAN TIGERS

With a photo

With reference to Mr. R. I. Pocock's article on the tiger in No. 3 of Vol. xxxiii of the *Journal*, may I make the following criticisms :—

(1) In giving measurements of skins Mr. Pocock has omitted the measurement of the tail. I contend that any measurement of total length which does not also give the measurement of the tail is valueless. Mr. Dunbar Brander states that he has known the tails of tigers to vary in length by as much as 15 inches.

(2) In quoting from Rowland Ward's *Records of Big Game*, Mr. Pocock has misread the column headings. He has taken 'the length before skinning' to be the length of the skin. Also he does not realize that the measurements have been taken in different ways : i.e. straight, and over the curves.

He surely cannot be serious when he refers to H. A. White's 10′ 7″ tiger from Annam, which is second in the *Records* and has the fourth biggest skull, as merely up to the average of Indian tigers. Then to write of A. Simonds' 10′ 0½″ tiger, with a *dressed skin* of 11′ 7″, as being below the average is absurd. Both these are very big tigers. The comparative field and skin measurements of this last tiger indicate that it was measured straight between pegs.

Incidentally Mr. Pocock refers to a tiger of mine from Siam which measured 9′ 3″ between pegs and has a dressed skin of 10′ 3″, as being smaller than the average Indian tigress. This skin lost a good deal by being dried on a frame and not pegged out, owing to the damp ground, but it would be a good average tiger anywhere in India, while an 'average tigress' measures a foot less, straight.

Mr. Pocock also refers to this tiger as 'unsexed'. Throughout the '*Records*' the want of a sex mark indicates a male.

(3) In comparing the size of tigers from Burma, Assam and the Malay Peninsula, Mr. Pocock can surely not have studied the list of skulls in *Records of Big Game*.

Taking Cooch Behar as zoologically part of Assam, five of the six biggest skulls came from those areas. Mr. Pocock will admit that size of skull is an excellent index to size of body.

It must also be noted that fewer tigers are shot in those areas, from which big specimens can be selected.

(4) As regards markings.

The two male tigers with most and least markings which I have seen personally, I shot in the same valley in Siam within a couple of miles of each other.

It is natural to expect that tigers living in heavy jungle will be darker in ground colour than those from, say, the Terai, and this is the case.

The tiger with fewest markings which I have seen, was a tigress shot by me in the Magwe district of Upper Burma, and illustrated in my book, *'Big Game Shooting in the Indian Empire.'*

From this, and from studying hundreds of skins, it would appear that there is no constant rule in the matter of markings where tigers are concerned.

May I suggest to Mr. Pocock that he will find full and conclusive information to be obtained by a critical study of (*a*) the information given by Sir John Hewitt on page 474 of the *Records* (*b*) the 'area measurements' given on page 476.

To point this last remark I enclose a photo of the forequarter of a big tiger shot by me in Kheri last January, of which the following were the measurements. Straight between pegs 9′ 6″; tail 2′ 11″. Body, between pegs 6′ 7″; over the curves 7′ 1″; total over the curves 10′. Girth of forearm 21″. Height at shoulder 39″.

Pegged-out. Total length 11′ 7½″.
Tail 39″.
Width of skin at narrowest part 4′ 8″.
Across forepaws 8′ 8″.
Across hind paws 7′ 9″.

Undoubtedly a big tiger, yet, by Mr. Pocock's computation, equal to an average Indian tigress.

Of course the above 'pegged-out' measurements will be reduced in curing. The skin has gone to Messrs. Rowland Ward for

treatment, who will doubtless let me have the area dimensions in due course.

Although this tiger has an unusually short tail, I think I have shown the fallacy of computing the size of tigers by total length of skin.

To judge the range of markings in skins from the same area, Mr. Pocock should see the hundreds of skins in Bikanir, Gwalior, and other collections in India.

FORT SANDEMAN, C. H. STOCKLEY,

March 4, 1930. *Lt.-Col.*

VI.—MOVEMENTS OF TIGERS

I have been recently transferred, (though not to a better land) and I was informed of my impending transfer first by a telegram from the Private Secretary to H. E. the Governor, then by a D. O. letter from the same official, and then by my appointment being notified in the *Bombay Government Gazette.* Finally I arrived here. Everything was done in due order.

But is any explanation available of how the transfers of tigers are arranged? In Khandesh, and presumably in other parts of India, the country is divided into districts, each occupied by a resident tiger. On the transfer of an incumbent to a better land, the vacancy is almost at once filled by his successor taking over charge.

How is the vacancy notified and who communicates it to the transferee? If there is a supply of *umedwar,* or candidate, tigers always mouching round on the chance of stumbling into a vacant post, one would presumably meet more tigers about than one does. Or is there a Central Tiger Reserve Depot or Training Battalion in Central India, from which a competent acting tiger is appointed to an acting vacancy with the possibility of being made permanent if suitable, or of losing it if shootable? If so, how is Headquarters notified of an incumbent's decease? Are transfers notified in the *Feline Government Gazette,* or in the *'Tigers of India'*?

I have no adequate explanation, and seriously I should like to know.

COLLECTOR'S BUNGALOW, H. F. KNIGHT.

SHOLAPUR,

January 2, 1930.

VII.—TIGERS SWIMMING

Lately a report appeared in the local press of a tiger having swum from the Mainland to the Island of Penang, a distance of about 5 miles or so, and surprise was expressed at the feat.

During several years of shooting in the 'Sunderbunds' forests (Bengal), I discovered that tigers there readily take to water and in some instances swim considerable distances (3 or 4 miles), and that, in tidal rivers, with a 4 to 5 knot tide running during

Spring tides, but what struck me most, however, was the intelligence displayed by tigers in choosing their time for swimming, which was invariably at or about high water, when they were able to 'take off' and land on hard ground, and anyone who has had experience in the 'Sunderbunds' will appreciate what this means!—At all other states of the tide one has to flounder up several yards of bank through more than knee deep mud, which would prove very embarrassing to a heavy animal like a tiger.

Another curious feature about the 'Sunderbund' Forests is the entire absence of fresh water (except in cultivated areas);—there are no fresh water ponds or streams, and tiger, deer, etc. have nothing but salt water to drink during the dry season, i.e. November—May, which seems hardly credible, but which nevertheless I am reliably informed is a fact.

Fresh water is however obtainable in the Islands in certain suitable localities, but one has to dig 4 or 5 feet deep for it, and this is the only method of replenishing stocks of drinking water if one is making a prolonged stay in or around the uninhabited islands on the sea front.

These fresh water 'holes' are soon discovered by the game who go mad after the water, and on one occasion I sat up over a hole to watch the game that came to drink, and spent one of the most enjoyable nights in the forest. Numberless cheetal, pig, jackals, and whilst I was dozing, a tigress and two half-grown cubs visited the hole, and the next morning I found tracks of a large monitor lizard and a python who had also quenched their thirst.

These holes have to be dug at a wide angle, i.e. about 45° (saucer shaped), as otherwise the walls collapse owing to the large amount of sand in the earth, and it is for this reason also that the holes soon 'dry up' through the game pushing back the earth and sand in trekking up and down the sides or walls of the hole.

SINGAPORE, W. A. HICKIE.
November 12, 1929.

VIII.—PROPORTION OF SEXES IN TIGERS

Mr. R. C. Morris's note in Vol. xxxiii, No. 4, indicates that in the District referred to the proportion of sexes accords with frequently recorded experience. But in the Deccan between 1895 and 1899 my diary shows 26 tigers and 14 tigresses killed.

The difference in the case of panthers is not so great—16 males to 12 females.

January 30, 1930. R. G. BURTON,
Brigadier-General.

IX.—AN EXPERIENCE WITH A TIGRESS

Mr. S. Hanhardt's experience with a tigress (see Note No. VII, Vol. xxxiii, No. 4) sounds to me very like a case of a tigress *with cubs.* A somewhat similar instance occurred in my case about five years ago, and on killing the tigress I discovered tracks of

large cubs round the dead body of a sambhur hind the tigress had killed and partly eaten. I searched the jungle in the vicinity but could find no further trace of them. The cubs were unfortunately large enough to get away on hearing my shots, but were apparently not old enough to kill for themselves : and to my regret I later heard that one had been found dead and another in a very weak and emaciated condition, was knocked on the head by a herdsman. I have the head and skin of the latter.

Tigresses, with cubs seldom charge home when trying to scare off intruders. Their charges are in the shape of demonstrations.

HONNAMETTI ESTATE,
MYSORE, S. INDIA,
March 2, 1930.

R. C. MORRIS.

X.—TIGERS EATING THEIR YOUNG

I was recently asked whether the female tiger is the one that eats the young in large litters or whether they are eaten by the male. In my opinion both eat their young on occasions. I think that a tigress with a large litter is very likely to eat the weakly ones. In the case of the tigress with five cubs which Lt.-Col. Hill-Dillon and I came across in January 1925 I fancy that at least two of these would probably have been killed sooner or later by the tigress, or possibly would have fallen a prey to the first tiger that came along; and just as sometimes a nervous mother-cat will eat her kittens when disturbed or worried I should think it highly probable that a tigress would do the same. That a tiger will kill and eat any small cubs it may happen to come across, provided of course their mother is not on guard over them, is I think fairly certain and must frequently occur.

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE,
(SOUTH INDIA),
February 19, 1930.

R. C. MORRIS.

XI.—THE LUCK OF HUNTING

It was on a very wet afternoon during the rains of 1922 that S. and I got news of a tiger killing a poor villager's buffalo, in a particular district where tigers were never heard of, and we hardly believed it, though we decided, eventually, to try our luck, and that was our first experience with tiger.

Riding 10 miles with heavy rifles slung on to one's shoulder is not a thing one would like to do every day. On arriving at the scene of the catastrophe we were rather tired. We discovered that it *was* a tiger and that he had killed a big buffalo and had eaten a portion of it, leaving the rest hidden under the thick undergrowth. We asked the *shikari* to arrange a beat. He started to build a *machán*, cutting away branches and small trees on the spot,

making enough noise to drive away even the boldest tiger (this we realized later).

At 1 p.m. we got into our *machán* but the beat did not start for two hours, and took another two to get up to us. We later discovered that the tiger had escaped about three hundred yards to our left, most probably long before the beat started.

In those days the latest books published on shooting were by The Honourable J. W. Best (*'Indian Shikar Notes'*) and H. H. the late Maharajah of Gwalior, from which we had theoretically learnt a little: but when the chance of using our wits came, we lost our heads and allowed the *shikari*—Moorad Mohamed by name—to make a mess of the whole show under our very noses. We returned home heavy at heart, but benefited from some practical knowledge of the King of the Indian jungles. From that date we decided to shoot at least one tiger each.

1923 found S. and myself each applying for a block, in one of the many districts of Central Provinces. Even S.'s old father—who was very keen to go on another shooting expedition before he got too old—applied for a block. Unfortunately, we were unable to get the permits. (This misfortune we shall always remember, because the next year, just when shooting was in full swing, the old veteran died.)

In May 1923, we received an invitation to join a shoot of H. H. the Rajah of . . . where poor S. missed his first tiger when it galloped past his *machán,* which was over 20 feet high. S. returned to the camp on one of the Rajah's many elephants with hardly any life left in him, and another few days found us rushing home in one of the fastest mail trains from one end of India to the other.

In that part of India elephants are numerous: so our host had made it a point to build his *macháns* over 20 feet, for (as he put it) the safety of his guests.

They have a curious way of beating. They surround a very large piece of jungle—as much as 4 square miles and gradually begin to close in till they reach the line of the *macháns,* which are in the middle of the large surrounded ring. The number of beaters varies, from two thousand men to sometimes five thousand. Any animal may come to you, from a herd of elephants to a mousedeer! This way of beating may sound unsporting, but there they still follow this custom.

In April 1924, I got an average block in Central Provinces but poor S. had just lost his father—the best heavy game shot of his day in our district—so S. could not come.

Again in November of 1924, I was quick enough to apply for a permit to shoot for one month, 15th January to 14th February 1925, in one of the best blocks that I knew of then in the Central Provinces. Fortune favoured me and I got the permit. Fortune favoured us still further and S.'s brother got another block adjoining mine. In this shoot S. was generally given the best *machán* in the beat—the first chance to sit up over a kill—in short, every effort was made to get him his first tiger, but he had no luck.

One day S. sat up at 2 p.m. The tiger came from behind at 4 p.m., saw S. and went off like a streak of lightning.

It was a pleasant surprise to get a good bag in two of the best blocks of the Province, but disappointment followed and S. lost his sister and had to return home. The day he left, a kill was reported and two tigers walked underneath my *machán* and I got one!

In December 1925, I applied for a block in a certain District, and was refused; I applied for another, and was refused; and I applied for one in yet another district—for any wretched block where we could just go and enjoy a few days in the jungle apart from shooting—but no luck. S. is one of those persons who never give up hope and went on trying to get a permit to shoot. Eventually a kind friend got us a permit to shoot in an Indian State. To this place we bound all our hopes, and four days of Railway, motor, and cart journey found us at the little Dak-Bungalow in the first week of April.

On the 11th of April 1926, we had a beat—our first—and S. having become rather superstitious, would not take the best *machán*, so the honour of the day fell to me and I was lucky to get a fair-sized tiger.

The moment we reached the Camp, there was a man waiting with news of a natural kill within two miles of our Camp. S. volunteered to go at once and was in his *machán* by 6, which naturally had to be built very hurriedly. This time the village tiger surprised him by appearing on the scene at 6-30, and spotted S. before coming near the kill.

After two days we changed the Camp. By now it was getting terribly hot, with very little water left in the river beds.

Next day the great Narishimulu—our shikari—smelt tiger in a little patch of green cover, ten minutes walk from our new Camp. We just walked out with a few men to try our luck, and sure enough a tiger came straight up to S. and just as he was going to take a head shot at about 12 yards, a jealous member of our party, Mr. . . . fired and possibly missed, because another boy sitting with S. seeing no damage to the animal, fired and dropped it. And then, horror of horrors, Mr. . . . poured lead into the dead animal and there were no less than twelve bullet holes in the body. It was impossible to say who really shot the animal, but as Mr. . . . claimed to have done it we let him have it to avoid a scene.

After this we returned to our first Camp and another beat followed in two days time. S. was again given the best *machán*, and sure enough a Tiger made straight for his place but Mr. . . . again fired, doing no more than frightening the tiger, which passed S. at a very great speed, thus causing poor S. to lose his last chance of the season, as in a day or two we had to leave camp suddenly on urgent business. Having lost three chances in twelve days S. was bitterly disappointed!

S.'s first luck started in August 1927, when he got a panther. Owing to long grass we could not see the panther until he was within 15 yards, and then he saw us before we saw him, and was

just running away when S. snapped him with a fine shot, saying the panther had only one eye, and in reality he was one-eyed!

We got a permit to shoot tigers in a certain district where they were doing damage to cattle, during the months of December 1927 and January 1928. We (a party of four friends, no jealousy this time) reached our destination at 8 p.m. on the 21st December 1927, but had no luck till the 26th. On the morning of the 27th I went out to a big village, seven miles from our Camp to get butter, vegetables, chicken, etc. and shot a couple of partridges on the way. While returning my motor stopped within 500 yards of the Camp and I had great difficulty in getting it pushed to Camp where, on my arrival, I was delighted to hear the news of a kill, and somehow or other it was not till 2-30 that the beat started. At 3 S. had fired his first shot since May 1923 at a tiger which dropped to the first shot and crawled a few yards before dying. There was great rejoicing and shouts of congratulations from all sides at the triumphant return with our trophy in the 11 h.p. Citroen—a fine tigress, 9′ 3½″ between pegs, weighing 287 lbs. The next day we sent our car for champagne to the nearest town, 30 miles away, and great was the rejoicing and many fine speeches followed that night. Then we changed Camp and went to another place about 32 miles away. Here on the 2nd January 1928 a kill was reported. Great hopes, as three tigers were expected in the beat.

The beat started at 2 o'clock and I wounded one very badly within twenty minutes. I have always made it a rule to have some signal to stop the beat as soon as a tiger was wounded. This time I had a hunting horn and I blew it till my lungs nearly burst and eventually managed to stop the beat. All the men climbed up trees, quite out of danger, according to instructions given before the beat. We all concentrated and had a council of war and tried to locate the tiger, but failed for the time being and decided to let the men make as much noise as possible from their safe perches in the trees, and that a few ·12 bore guns be fired by the shikaris from their perches. S. had not troubled to build a *machân* and was standing on a branch just high enough to be able to see things in thick grass. The firing and shouting produced good results, as in ten minutes, 'bang' went S.'s ·450 and then all was silent. We were informed by S. that he had dropped a tiger, but could not see it because of long grass. We worked round and had a careful look from the other side and found the tiger stone dead, 193 feet from where S. was—a fine young male, three-quarter grown, measuring 7′ 9″ between pegs. Then the other one was searched for and found just a few yards from where it was hit. It charged, although badly wounded, but a fine shot by S. put the life out of it—a tigress 7′ 7″. Another tiger to the credit of S. and there was to be yet another. On the 5th, he was sitting on the bank of a river and I was in the river bed on a small tree. We were not fifty yards from each other. Within fifteen minutes of the start of the beat the tiger came out and we both saw him, but he was nearer to S. Still S. did not shoot and let him come to me and I was fortunate to drop him in his tracks,

thanks to S.'s generosity—a larger Tiger never known in that district.

Measurements	...	10′ $3\frac{1}{4}$″ between pegs.
Weight	...	495 lbs.
Girth behind shoulders	...	52″
Round stomach	...	63″
Tail	...	44″

Thus ended our successful shoot—pleasant surprises and no disappointments.

ALIRAJPUR, 'A NOVICE.'
December 10, 1929.

XII.—HYAENAS KILLING CATTLE TIED UP AS BAIT

I have recently had two baits, which had been put out for tiger, killed by hyaenas, which I think occurs more often than sportsmen think; in fact I have rarely seen cases mentioned.

In the first instance my shikaries informed me that a panther had taken the bait, but on examining the kill I was puzzled to find that there were no traces of either fang or claw marks on its throat or head, and there were hyaena tracks all round the kill. As authentic cases have occurred of a hyaena taking possession of a panther's kill and even driving off the latter I thought that possibly a similar case had occurred here. I sat up over the kill for two successive nights and sure enough only a hyaena turned up on both nights.

Two days ago another kill occurred and on reaching the spot I was surprised to find that here again there were no marks on the throat or head of the kill, tracks of hyaena in plenty, and one hind leg had been completely removed from the kill and was not to be seen. My suspicions that both these cows had been killed by hyaenas were to my mind confirmed by the arrival of a large hyaena on the scene shortly after dark, and I took great pleasure in shooting the brute.

This hyaena may possibly have been responsible for both kills but I consider it doubtful as the two baits had been tied up some miles apart.

It is not uncommon for hyaenas to make a meal off tiger and panther kills, and they quite frequently kill and take off calves, sheep, goats and dogs, but I have never heard of hyaena killing a full-grown cow before. Both cows must have been literally eaten alive, and I am convinced that in each case the hyaena must have downed the bait by chasing it round the tree it was tethered to until it tripped over its rope and fell, its stomach being immediately ripped open by the hyaena, a horribly cruel death.

HONNAMETTI ESTATE, R. C. MORRIS.
ATTIKAN P.O.,
Via MYSORE,
(*S. India*),
February 26, 1930.

[The hyaena is generally looked upon as a cowardly animal but we have published two interesting notes on encounters between hyaenas and panthers in each of which the hyaena was victorious.

Capt. R. C. Burke (*Journ.*, Vol. xix, p. 518) writes of a panther attacking a hyaena which it found in the neighbourhood of its kill. A grand old scuffle ensued and the conquering hyaena came to carry off the spoils of war. She was a female measuring 5′ 11″. On page 979 of the same volume, Mr. W. M. F. Pendlebury gives an account of a fight between a hyaena and a wounded panther which took refuge in a deep cave. The proprietor of the cave, a hyaena, gave battle and emerged shortly afterwards somewhat badly scratched about the face but otherwise uninjured. The panther was found lying outside the cave stone dead. She had a flesh bullet wound in the neck not sufficient to kill her, but she had been bitten in two places by the hyaena. Firstly through the loins and then through the kidneys, at the same time her spine was injured. The writer is confident that the panther died of the injuries received from the hyaena.

Captain, now Col. A. H. E. Mosse writing of the Spotted Hyaena in Somaliland, (*My Somali Book*, p. 35), speaks of their attacking cows. Their method is to tear out the udders of the cow in a most cruel fashion. Similar and equally successful attacks on straying cattle are not unknown. The writer quotes Drake Brockman (*Mammals of Somaliland*) who states that they often attack horses biting great pieces out of their hind-quarters. Our Striped Hyaena also occurs in Somaliland where according to Mosse he appears to be decidedly more aggressive than here in India. He develops the habit of running *amock* among a flock of goats or sheep, killing a dozen or more from sheer lust for slaughter. EDS.]

XIII.—BODY MEASUREMENTS OF A GAUR

In connection with the note on 'Body Measurements of a Gaur by Mr. I. L. Cameron of Ceylon in No. IV, Vol. xxxiii of the *B. N. H. S. Journal,* the following letter to me from Mr. De Wet Van Ingen of Mysore will be of interest.

'In reply to your letter of the 7th instant for which I thank you, the bison measured 5′ 11½″ at the shoulder—length from middle of forehead to stump of tail 8′ 1″. He had a head with a 41″ spread and 81½″ from tip to tip.

I came across him lying in a teak clearing and got up to a tree stump on which I fixed my Graflex Camera and then told the kurba to break a couple of dried sticks and took a snap of it as it walked up to me, and then used my ·470 when he was at a range of 15 paces, firing into the chest.

I gave Mrs. Morris a copy of the photograph. Unfortunately the only two teak saplings in the vicinity were in his way, for the photograph. When I fired he was right out in the open.

HONNAMETTI ESTATE,
ATTIKAN P.O.,
Via MYSORE,
(*S. India*),
February 20, 1930.

R. C. MORRIS.

XIV.—GOOD HEAD OF NILGIRI TAHR

It should be of interest to record that a very fine specimen of a Nilgiri Tahr, locally known as 'Ibex,' with horns measuring—left $15\frac{1}{4}''$; right $15\frac{1}{2}''$ in length, and girth $8\frac{3}{4}''$ for both horns at the base, was shot in this District on March 28, 1930.

Mr. Lane (Indian Police) and I and some shikaris were out searching the hills for Tahr in the evening of March 27, 1930, when we came across this beast. We fired and only succeeded in wounding it, apparently by a shot of mine, and it disappeared down the side of a semi-precipitous cliff. When next seen by me, its off fore-leg was seen to be shattered at the shoulder. The Tahr was able to keep up a most remarkable pace considering its enormous size and the fact that it had only three legs to move on. Unfortunately for the poor beast we were unable to bag it that night.

Next morning, March 28, 1930, I went out with an Orderly, Cons. 1563 Kuttan Nair (Malabar Special Police) and some shikaris and proceeded to the spot where it had been approximately located the previous evening. After a search, it was heard making off in the undergrowth and Cons. Kuttan Nair followed it for some distance more down this cliff, and eventually shot it when it stopped for a breather in the shelter of some bushes.

The measurements noted above for the length have been taken along the outside of the curve from the tip to the end of the small projection of horn on the inner side of the front of the base of the horn. From records I have seen in books, this appears to be the 4th largest horn which has been recorded. I should be glad if you would kindly inform me whether this is correct. I should also be interested to know whether any large Nilgiri Tahr heads have been shot within recent years. The measurements are corroborated as above by Mr. Lane.

MALLAPURAM,
MALABAR,
April 7, 1930.

H. D. LATHAM,
(*Indian Police*).

[The biggest Nilgiri Tahr head is in the British Museum (Hume Collection); it measures $16\frac{3}{4} \times 8\frac{7}{8}$ inches. A very fine head was recently presented to the Society by Capt. R. H. Irvine—it measures $16\frac{1}{2} \times 9\frac{1}{2}''$. EDS.]

XV.—THE DISTRIBUTION OF THE MOUSE-DEER

In the last issue of the *Journal*, Mr. F. W. Champion queries the existence of the Mouse Deer in the Southern United Provinces.

In February 1903, I shot a Mouse Deer in some low hills about 10 miles North of Nowgong in Bundelkhand.

I had recently come from S. India, where I had met with the Mouse Deer, but noticed that the shikari and coolies with me pointed to the little animal and chattered amongst themselves; then asked me questions, which I could not understand, owing to their very meagre supply of Hindostani. I got the impression that I had shot something I ought not to, and did not mention the matter

except to a brother subaltern of equal callousness, who, on being asked by me whether Mouse Deer were sacred in that part of the world, replied 'What's a Mouse Deer?'

I have more recent evidence, however, for I saw a Mouse Deer in the Dhera Sagar block of the Lalitpur District in the end of March 1928. This is very close to districts where Mr. Champion states they exist, but still is in the Southern United Provinces.

As far as the Siwaliks are concerned I must plead guilty to a worse crime then a slip of the pen. I was talking to a well-known shooting enthusiast, who had spent many pleasant weeks in the Siwaliks. He made use of the expression that 'a morning walk in the Siwaliks might produce anything from a tiger to a mouse-deer,' and the phrase seemed as apt, and expressive of my own memories of my only visit to the Siwaliks, that I stole it and never checked its accuracy.

Mr. Champion has caught and convicted me.

FORT SANDEMAN, C. H. STOCKLEY,
January 18, 1930. *Lt.-Col.*

XVI.—NOTES ON THE 9TH EDITION OF 'RECORDS OF BIG GAME'.

On studying the 9th edition of Rowland Ward's *Records of Big Game* I have found a number of errors and inconsistencies introduced into this latest edition. As this most useful compilation is frequently consulted for purposes of reference, I think these inaccuracies should be marked down before they become ground for further error. The principal criticisms which I have to offer, and which refer to Indian game, are as follows.

(1) SWAMP DEER. (*Rucervus duvauceli*). p. 41.

The colour is described as 'bright rufous brown'. This would be applicable to the stag in the hot weather if 'light' were substituted for 'bright'. But most people see them in the cold weather, when the colour is a varying shade of rather dull brown.

(2) THAMIN.

On pages 45, 46 and 47, three 'species' of thamin have been formed from the former one. In addition to *Rucervus eldi* we now have *Rucervus thamin* and *R. platyceros*. *R. eldi* is given as the designation of the Manipur animal, the Burmese being *R. thamin*, and the Siamese *R. platyceros*. The Manipur beast is distinguished from the Burmese by having naked pasterns: surely a mere racial characteristic, and locally caused by the animal wearing off the hair by continuous existence in swamp. The Siamese 'species' is distinguished by having palmated horns: a characteristic found also in Burmese heads, and by no means universally in Siamese heads. Of seven heads which I examined on the Meping river, only two had palmation, one very little. The division of the thamin into three different species on such unsatisfactory grounds seems quite unjustified. Again we are informed that the thamin of Upper Burma belongs to a race called *R. thamin brucei*. This was

described by Oldfield Thomas from two heads which came from the same herd and were almost certainly the progeny of one master stag. They are not in the least typical of heads from Upper Burma and, in fact, are merely local aberrations. There are no constant characteristics distinguishing the thamin of Upper and Lower Burma.

(3) HOG-DEER. (*Cervus porcinus*). p. 57.

Under 'distribution' no mention is made of the Indus Valley, the distribution being given as 'throughout the Indo-Gangetic plain from the Punjab to Assam. . . .' This is certainly much too comprehensive. I have yet to hear of a specimen from the Punjab, and outside the swamps at the foot of the Himalayas, it is confined, in Northern India, to the islands of the lower Indus River.

(4) BLACKBUCK. (*Antilope cervicapra*). p. 218.

The head belonging to the Maharajah of Jind, and recorded under 'owner's measurements' as $32\frac{1}{4}$ inches in length, I measured as $31\frac{3}{4}$ when the head was sent to the Society to be mounted. I cannot understand the difference. The head is more likely to have shrunk half an inch.

(5) THE SEISTAN GAZELLE. (*Gazella seistanica*). p. 224.

No mention is made of the females having horns, in contrast to the preceding and subsequent species, *G. yarkandensis* and *G. fuscifrons*.

(6) THE CHINKARA. (*Gazella bennetti*). pp. 224, 225.

The distribution, 'Peninsular India', must be a slip. This gazelle is also found all over Northern India and on both sides of the Indus. Contrary to the description given, the points of the horns turn in distinctly in many specimens from the west of the Indus. It is possible that there is a distinct race there.

(7) SEROW. (*Capricornis sumatrensis*). p. 321.

The astounding information is given that the head of the Kashmir Serow (here designated *C. s. humei*) is rufous brown. Having seen and shot many serow in Kashmir and the Chenab Valley, I emphatically contradict this statement. The Kashmir Serow has a black head, with a variable amount of white spots and patches, usually about the lips and throat.

I will also venture to assert, with absolute confidence, that the Kashmir and Chamba serows are identical, and that there are no grounds for separating the latter under the racial name of *Capricornis sumatrensis rodoni.*

Again, in Arakan, both black and bright rufous serows are found; the latter being a colour-phase which extends in a belt right across Upper Burma and is found occasionally in Assam, and even near Naini Tal.

No mention is made of the curious purplish bloom on Malay and Siamese serows.

(8) MARKHOR. (*Capra falconeri*). p. 341.

Col. A. B. Souter's record 65 inch head is illustrated as an Astor markhor. It was obtained on the North flank of the Kaj-i-Nag Range, and is not an Astor head.

It is very typical of the race to which it belongs, and is by no means like the typical Astor head.

(9) ASIATIC IBEX. (*Capra sibirica*). p. 343.

In enumerating the various alleged races of ibex, what is the distinction between the 'Balti Ibex (*C. s. wardi*)', 'the Himalayan Ibex (*C. s. skyn*) from the mountains to the northward of Kashmir', and 'the Gilgit race (*C. s. pedri*)'?

Looking at the map one would assume that Baltistan and Gilgit are both included under 'the mountains to the northward of Kashmir.'

In the list of heads on pages 344 and 345, the editors seem to have gone, geographically, still further astray; as, under 'Ladaki, Balti and Kashmiri races', they list heads from Gilgit, Chitral, the Pamirs, and Kashgar Mountains. This, to say the least of it, is inconsistent in the extreme.

The editors have given no distinguishing characteristic to guide the naturalist or sportsman to help him differentiate between these hypothetical races. It would appear that there are none.

(10) SIND IBEX. (*Capra hircus*). p. 351.

Heads from Mekran and the Taurus Range are classified both under *C. h. ægragus* and *C. h. blythi.* The editors would appear to have had the same difficulty in distinguishing these 'races' as with the Himalayan Ibex. They do not tell us what is the 'slight difference in the shape of the horns' which distinguishes them, and, if they have seen the wide variation in this respect which I have seen in a single herd, no wonder they are puzzled.

(11) THE BANTIN OR TSAINE. (*Bibos banteng*).

No mention is made of the great variety in colour to be met with in old bulls; although such variety is peculiar to this species alone.

I have seen in one area in Upper Burma, about 20 miles square, and in the same month, bulls of the following shades of colour :— khaki (oak-leaf), copper-beech leaf, french grey, buffalo blue, dark bay, chocolate. All of these were fully adult bulls. Major G. P. Evans has recorded three black bulls in the Chindwin Valley.

(12) THE SUMATRAN RHINOCEROS. (*Rhinoceros sumatrensis*) p. 440.

The rear horn of the specimen entered under 'owner's measurements', shot by A. S. Vernay, is shown as measuring 14 inches in length. As this specimen was a female, and had a front horn of only 6 inches in length, it is evident that the circumference of the front horn has been transposed to the wrong column. The longest rear horn on record is 7½ inches.

Tiger. At last we have a good system of estimating the size of tigers from their skins, and the details given under 'area dimensions' on page 476 will do much to allay the craving for length which has led to such amazing records being claimed and

to skins being pegged out so as to look like the outer coverings of large, striped greyhounds.

'Area dimensions' are of scientific interest and value.

In making the above criticisms I will not, I hope, be accused of not crediting *Records of Big Game* with its immense value, both to Science and Sport.

It is only by such criticisms that one can arrive at true facts, and avoid a multiplication of species and races being admitted by default of criticism, which are based on insufficient and inconclusive material.

We owe (I write both as a naturalist and a sportsman) an incalculable debt of gratitude, both to the originators and the present editors of the book.

FORT SANDEMAN, C. H. STOCKLEY,
BALUCHISTAN, *Lt.-Col.*
March 8, 1930.

XVII.—NOTES ON THE MAMMALS OF BALUCHISTAN

A year's residence in the Zhob Valley, and a good deal of travelling in the surrounding country, has convinced me that Baluchistan remains the most interesting part of India, zoologically speaking.

The first thing that strikes one is the wide distribution of the larger mammals in spite of their comparative scarcity; and the number of species to be found, contrary to generally accepted ideas.

The Leopard, Wolf (*Canis lupus*), and Striped Hyaena are scattered all over the Baluchistan Agency, and, as these species are great travellers, this is not so remarkable.

But what is very notable is the number of localities where the Himalayan Black Bear occurs. I know of them personally on the Tahkt-i-Suliman massif, at the head of the Kuchmina Valley, and have reliable information of their occurrence in several of the ranges west of the Zhob River, at over 6,000 feet. Everywhere they are scarce, are shot at whenever seen, and it is wonderful how they continue to exist.

Oorial (locally called '*gud*') are scattered all over the district, are still fairly plentiful in spite of much shooting, and good rams are still to be met with fairly close to main roads. A very fine ram was shot recently near Sheghalu Post, west of the Zhob River, by an Indian Officer of the Zhob Militia. The horns measured $39\frac{1}{4}''$ right, and $38\frac{3}{4}$ inches left, and are, I believe, the longest pair now in existence. Major Dodd's head of $41\frac{1}{2}''$, shot by a Jemadar of the Wana Militia, was destroyed in Wana in 1919, and I believe that Major Taylor's $39\frac{1}{2}$ inch head, picked off a ziarat in Waziristan, is also no longer in existence.

Straight-Horned Markhor are still to be found in many localities, but have been terribly shot down, and good heads are very hard to find. I have made an expedition to each of two formerly famous localities,—the Takht-i-Suliman and the Kuchmina Valley,—without seeing a single shootable head. The type of horn is very distinct from the different ranges as a rule.

Both the Chinkara (*Gazella bennetti*) and Kennion's Gazelle (*Gazella fuscifrons*) are found in Baluchistan. The former, (possibly a distinct race) seems to be found east of the Zhob Valley, and Kennion's Gazelle, in the Valley itself, but the distribution is not yet accurately known.

FORT SANDEMAN, *March 8, 1930.*

C. H. STOCKLEY, *Lt.-Col.*

XVIII.—MIGRATION OF WILD FOWL

Since the publication of Vol. xxxiv, No. 1, of the *Journal,* the following recoveries of Ringed Birds have been reported to us.

Place of Ringing	No.	Date	Species	Ringed by	Date of recovery	Locality	Remarks
Manchar Lake, Sind.	3110	March 8, 1929	Wigeon M. penelope.	Haji Rab Rakhro Lakho.	Jan. 7, 1930	Anchar L. Between Gardebal and Srinagar.	Adult. ♂
Do.	3384	Jan. 23, 1929	Do.	R. B. Maclachlan.	Sept. 20, 1929	Nishny Arenzyare Tobolsk Dist., Siberia.	Adult ♀ Recovery after 246 days. 2,300 miles due north of place of ringing.
Ghagga Bahawalpur.	2195	Dec. 12, 1928	Mallard Anas platyryncha.	G. Atkinson.	March 10, 1930	Mastug, Chitral State Lat. 70°-30′ Long. 36°-15′ reported by Lt. Stockley Roper.	Recovery after 369 days.
Manchar Lake, Sind.	3126	Mar. 16, 1929	Anas strepera.	Haji Rab Rakhio Lakho	March 11, 1930	New Boukhara (Russia) circa 40°N × 70°E.	
Hygam Lake, Kashmir	884	Mar. 18, 1929	Anas strepera.	Deputy Controller, State Rakhs	April 1930	Chalda (Kashmir State)	

Capt. G. Sherrif reported the recovery of 13 Mallard, *A. platyryncha* ringed by him at Kashgar, Chinese Turkestan. All these ducks were recovered at Kashgar or in its immediate neighbourhood within one to ten days from the date of ringing.

Regarding these recoveries Capt. Sherrif remarks that owing to a prolonged and excessively cold spell when the temperature after dusk fell to below zero, Fahrenheit (–12° F. once) the duck had become so emaciated and weak that a great number of those ringed fell within a short time an easy prey to dogs and hawks and were also shot.

EDITORS.

XIX.—MIGRATION NOTES IN 1929 FROM THE NILGIRI DISTRICT

I append a list of arrivals of winter migrants in the Nilgiri District which may be of interest.

Common Sandpiper (*Tringa hypoleucos*), 4th August.
Grey Wagtail (*Motacilla cinerea caspica*), 23rd August.
Willow-Warbler (*Phylloscopus tytleri ?*), 28th September.
Blue Rock-Thrush (*Monticola solitaria pandoo*), 3rd October.
Brown Shrike (*Lanius cristatus cristatus*), 7th October.
Common House-Swallow (*Hirundo rustica* subsp.), 8th October.
Black Drongo (*Dicrurus macrocercus macrocercus*), Local migrant, 15th October.
Indian Blue Chat (*Larvivora brunnea*), 23rd October.
Pale Harrier (*Circus macrurus*), 23rd October.
Green Sandpiper (*Tringa ochropus*), 25th October.
Indian Tree-Pipit (*Anthus hodgsoni hodgsoni*), 7th November.
Blue-headed Rock-Thrush (*Monticola cinclorhyncha*), 27th November.

NILGIRIS,
16th December, 1929. F. N. BETTS.

XX.—NOTES ON SOME BIRDS SEEN IN LAHUL AND KULU

LAHUL, 1929.

The Tibet Raven, *Corvus corax tibetanus.*

Great numbers of ravens in the Sarchu Nala in September. A few seen in Chokam Nala at Ninghar in the last week of September. Ravens were seen in the Chamba Valley from Lot to Sissu, 4–10 and 5–10–1929, after a heavy fall of snow.

The Wall Creeper, *Trichodroma muraria.*

A single bird seen in Chokam Nala near Guari on 28–9–29.

The Kashmir Wren, *Troglodytes trogolodytes neglecta.*

Several wrens seen in Chokam Nala, near Ninghar, 26–9 to 30–9–29.

The White-capped Redstart, *Chaimarrhornis leucocephala.*

A pair of these birds seen on several occasions in the Sarchu Nala about 14,300′ between 1–9 and 10–9–29.

The Himalayan Whistling-Thrush, *Myiophoneus temmincki temmincki.*

Plentiful in Chokam Nala at the end of September.

The Kashmir Dipper, *Cinclus cinclus cashmeriensis.*

Pairs seen—Kinlung, 27–8–29; Sarchu Nala, 14,000′ 5–9–29.

The Indian Brown Dipper, *Cinclus pallasi tenuirostris.*

Fairly plentiful at the end of September in Chokam Nala.

The Western Red-breasted Rose-Finch, *Pyrrhospiza punicea humii.*

Numbers of a very rosy-headed finch seen at Kinlung.

Severtzoff's Rose-Finch, *Carpodacus severtzovi.*

Zingzingbar on 10–7 and 9–7–29.

The Yellow-headed Wagtail, *Motacilla citreola* subsp.

Seen in Sarchu Nala at about 14,000′ in first week of September.

European Hoopoe, *Upupa epops.*

First seen at Sarchu Nala at about 14,000′ (a single bird) on 16–8–29.

Single birds seen Sarchu Nala, 14,000′ 17–8–29 and at Tsarp Nala, 13,000′, 18-8 and 19–8–29. Thereafter it was plentiful on the Lingli plains and surrounding hills till about 10–9–29.

The Turkestan Hill-Pigeon, *Columba rupestris turkestanica.*

Only seen beyond Kinlung. Very plentiful and tame.

Mallard, *Anas platyryncha.*

A single duck seen and shot on the 'lagoon' below Sissu-bungalow after heavy snow on the 2, 3, and 4–10–29.

Common Teal, *Nettion creca.*

Pairs seen as under :—

Kinlung, 9–8-28 on a small talao.
Sarchu, 10–8–29 to 12–8–29 on Yunan river.
Kinlung, 25–8–29 to 21–8–29.
Sissu, 6–10–29; shot on lagoon. An odd bird seen and shot at Kinlung on the 28–8–29.

A flock of duck, about the size of a Wigeon, dark in colour, were seen at Kinlung on the 27–8 and the 28–8–29 but were very wild whereas the Teal were quite tame.

An owl about the size of a Shot-eared Owl, was seen quartering the hillside above Sarchr Serai about mid-day on the 17–8–29.

A quail was found sheltering on the outer fly of my tent on the early morning of the 9–9–29 in the Quissmett Nala—about 4 miles up the Lingti river from its junction with the Yunan Stream.

KULU, 1928.

The Yellow-billed Chough, *Pyrrhocorax graculus.*

In early May, 1928, there were considerable numbers of this Chough at the Solang Nala, Kulu.

The Snow Pigeon, *Columba leuconota.*

A flock seen near Solang village, Kulu, 8,000′ on 26–4–28, thereafter for several days.

KULU,
December, 1929.

D. LOWNDES,
Capt.

XXI.—VERNACULAR NAMES FOR KASHMIR BIRDS

Name.	*Local Name.*
The Raven (*Corvus corax*)	Boṭiñ Kāv.
The Himalayan Jungle-Crow (*C. coronoides intermedius*)	Diva Kāv. Pañtsöl Kāv.
The Sind House-Crow (*C. splendens zugmayeri*)	Kāv.
The Eastern Jackdaw (*C. monedula sommeringii*)	Kăviñ.
The Kashmir Magpie (*Pica pica bactriana*)	Hôr Kāv (in Dras). Khashim Brāh. (in *Suru*).
The Red-billed Chough (*Pyrrhocorax pyrrhocorax*)	Wăn kăviñ. Wozij tonti kăviñ.
The Grey Tit (*Parus major kaschmiriensis.*)	Rangă tsăr.
The Crested Black Tit (*Lophophanes melanolophus*)	Tājdār tsăr. Pintsakön.
The Simla Streaked Laughing-Thrush (*Trochalopterum lineatum griseicentior*).	Sheen-ă-pi-piñ.
The White-cheeked Bulbul (*Pycnonotus luteolus*)	Bill-bi-chur.
The Himalayan Black Bulbul (*Microscelis p. psaroides*)	Wăn bulbul. (Khruhun bulbul).
The Tree-Creeper (*Certhia sp.*) ...	Koel dider.
The Wall Creeper (*Tichodroma muraria*) ...	Lambă dider.
The Indian Bush Chat (*S. t. indica*) ...	Dofa Tiriv.
The Western Spotted Forktail (*Enicurus m. maculatus*)	Shakhel-loṭ.
The White-capped Redstart (*Chaimarrhornis leucocephala*)	Chets tăl. Kumidi (in *Kolahoi*).
The Plumbeous Redstart (*Rhyacornis fulginosa fulginosa*).	Kola Tiriv.
The Blue Throat (*Cyanecula suecica*) ...	Nyul hôt ?
The Ruby Throat (*Calliope pectoralis*) ...	Yaquat hôt ?
The Grey Headed Thrush (*Turdus castaneus castaneus*)	Wăn Kostūr.
The Black-throated Thrush (*Turdus atrogularis*)	Wandă Kostūr ?
The Missel-Thrush (*Turdus viscivorus*) ..	Techal Kostūr.
The Whistling Thrush (*Myiophoneus temmincki*)	Hazār dāstan.
The Tickell's Thrush (*Turdus unicolor*) ...	Kostūr.
The Hedge Sparrow (*Laiscopus*) ...	Zanda tsăr.
The Paradise Fly-catcher (Male) (*Terpsiphone paradisi*) (female & young).	Fhaṁbăsīr. Rangă bulbul.
The Rufous-backed Shrike (*Lanius schach erythronotus*).	Hāră wātij.
Minivet (*Pericrocotus sp.*)	Wozul Mini ?
The Drongo (*Dicrurus sp.*)	Gunköts.
The Reed-warbler (*Acroceptalus sp.*) ...	Kurkoch.
The Willow Warbler (*Phylloscopus sp.*) ...	Viri Ṭiriv.

Name.	*Local Name.*
The Chiff-chaff (*Phylloscopus collybita*) ...	Chip-Chip.
The Indian Oriole (*Oriolus kundoo*) ...	Posh nūl.
Starling (*Sturnus sp.*)	Tsiñi-hañgur.
Myna (*Acridotheres sp.*)	Hör.
The Dipper (*Cinclus sp.*)	Dungal.
The Grossbeak (*Perrisospiza*) ...	Wyeṭ toñt.
The Orange Bullfinch (*Pyrrhula aurantica*).	Sama Sonatser.
The Rose-Finch (*Carpodacus*) ...	Gulābi Tsăr.
The Gold-Finch (*Carduelis caniceps*) ...	Seharā.
The Gold-fronted Finch	Tiok.
(*Metaponia pusilla*) young	Tăer.
The Eastern Meadow-Bunting (*Emberiza cia stracheyi*)	Wan Tsăr.
The Swallow (*Hirundo sp.*)	Katij.
The Pied Wagtail (*Motacilla lugubris*) ...	Dāb-bai.
The Lark (*Alauda sp.*)	Jal.
The Small Skylark (*Alauda gulgula*) ...	dider.
The Green Woodpecker (*Picus*) ...	Koel Makkats.
The Pied Woodpecker (*Dryobates*) ...	Hör Koel. Makkäts. Koel Ku-kir.
The Wryneck (*Inyx torquilla*) ...	Viri Mot.
The Roller (*Coracias indica*) ...	Nilă Krăsh.
The Bee-eater (*Merops sp.*)	Tuleri Khāv.
The Pied Kingfisher (*Ceryle pudis*) ...	Hôr Kolā tonch.
The Central Asian Blue Kingfisher (*Halcyon sp.*)	Kolă tonch.
The Hoopoe (*Upupa epops*)	Satut.
The Cuckoo (*Cuculus canorus*)... ...	Shāh Kuk. Zoeb Kuk.
The Pied Cuckoo (*Clamator jacobinus*) ...	Hor Kuk.
The Parakeet (*Psitacula*)	Totă.
Owls	Rātă mogul.
Vultures	Grad.
White Vulture (*Neophron percnopterus*) ...	Paṭyāl.
Pallas' Fishing Eagle (*Haliaëtus leucoryphus*)	Gaḍă Grad ?
The Kite (*Milvus govinda*)	Gönṭ.
The Sparrow-Hawk (*Accipiter nisus*) ...	Tsări suh.
The Peregrine (*Falco peregrinus*) ...	Pöz.
Kestrel (*Cerchneis tinnunculus*) ...	Böher ?
The Rock Pigeon (*Columba livia*) ...	Wăn kotūr.
The Snow Pigeon (*Columba leuconota*) ...	Chut kotūr.
The Ring-Dove (*Columba palumbus casiotis*)	Kukil.
The Turtle-Dove (*Streptopelia orientalis*) ...	Wăn kukil.
The Monal (*Lophophorus impejanus*) ...	Male : sunal. Female : hām.
The Chukor (*Cacabis chukar*) ...	Kăkov.
The Snow-Cock (*Tetraogallus himalayensis*).	Gura Kăkov.
The Indian Moorhen (*Porphyrio poliocephalus*)	Tech.

Name.	*Local Name.*
The Coot (*Fulica atra*)	Kāvpūt. Kolur.
The Pheasant-tailed Jacana (*Hydrophasianus chirurgus*)	Gund kāv. Gāir kov.
The Ringed Plover (*Charadrius dubius*) ...	Kolă katij.
The Common Sandpiper (*Tringa hypoleucos*)	Ṭoñṭ kôn. Kolă Kăviñ.
The Redshank (*Tringa totanus totanus*) ...	Wozul nal ?
The Greenshank (*Glottis nebularia*) ...	Nyal nal.
The Woodcock (*Scolopax rusticola*) ...	Zar batchi.
The Fantail Snipe (*Capella gallinago*) ...	Chāh.
The Black-headed Gull (*Larus ridibundus*)..	Khrind.
The Brown-headed Gull (*Larus brunnicephalus*)	Bullur ?
The Whiskered Tern (*Chelidonias leucopareia*)	Krew.
The Cormorant (*Phalacrocorax*) ...	Mong.
The Grey Heron (*Ardea cinerea*) ...	Brag.
The Night Heron (*Nycticorax nyctiorax*) ...	Bör.
The Bittern (*Botaurus stellaris*) ...	Goi.
The Goose (*Anser*) ...	Ånz.
The Brahminy Duck (*Casarca rutila*) ...	Tsakov.
The Mallard (*Anas platyryncha*) ...	Male : Neluj Female : Thuj
The Gadwall (*Chaulelasmus streperus*) ...	Buḍan.
The Wigeon (*Mareca penelope*) ...	Shurini Buḍan.
The Garganey (*Querquedula querquedula*)...	Kolă Kilar.
The Teal (*Nettion creca*)	Keusput.
The Pintail (*Dafila acuta*)	Sokha pachen.
The Shoveller (*Spatula clypeata*) ...	Hoñk.
The Red-crested Pochard (*Netta rufina*) ...	Tūr.
The White-eyed Pochard (*Nyroca rufa*) ...	Hārăwoṭ.
The Tufted Pochard (*Nyroca fuligula*) ...	Khruk.
The Smew (*Mergus albellus*)	Gagur.
The Dabchick (*Podiceps ruficollis*) ...	Pind.

C. M. S. HIGH SCHOOL SAMSAR CHAND KOUL.

SRINAGAR,

December, 1929.

XXII.—THE ATTITUDE OF BIRDS TOWARDS THEIR YOUNG

With reference to your note to the Miscellaneous Notes in Vol. xxxiii, No. 4 to a question by Mr. Griffiths, the following may be of interest. About 1903, when stationed at Poona, a pair of White Eyes (*Zosterops palpebrosa*) built in my porch, a nest which was quite visible from the verandah. In due course, four young were hatched. I watched the process of bringing them up.

When the young were able to uplift their necks and open their mouths to receive their food, one could plainly see four mouths. In a day or two, it was noticeable that two of these were much more prominent. The other two were very much smaller and it was not long before they were found lying on the ground below the nest. It was of no avail replacing them for they were immediately evicted.

The idea conveyed to me was that, on the appearance of the parent, or parents, with food, the four necks were uplifted to receive it. The parents seemed to cram the food down the first throat they came across and to show no discrimination in distributing it fairly. The natural result being that the stronger young got the attention and so thrived, while the weaker made no progress and soon fell behind, on perceiving which, by the inexorable Law of Nature, their parents would have none of them, so flung them out.

From what I have seen during my life, not only confined to India, birds that bring up and feed their young in a nest neglect some of the brood, and rarely bring up more than a small minority. They seem to be very callous towards their offspring, so long as they can rear one or two. In the case of birds that have young which can fend for themselves at once, such as Lapwing, Snipe, Duck and so on, it is not the same among these; of course there are many casualties, not due, however, to want of food for they feed themselves.

It would be interesting to know whether my conclusions are correct, by others, interested in ornithology, giving their views on the point.

CAPE TOWN, R. M. BETHAM,
January 7, 1930. *Brig.-General.*

[When young birds are hatched as helpless nestlings the labour of feeding them is very great. Professor Newland has shown that a pair of Great Tits destroyed from 7000-8000 caterpillars during the twenty days in which they were busy rearing their young. While Dr. Collinge computed that a pair of Starlings visited their young with food no less than 370 times during a single day. Yet, as with most of the activities of the nesting bird, the actual feeding of the young is in the main an instinctive act. With the majority of birds it is haphazard. It is not governed by intelligent discrimination as to the more pressing needs of a particular offspring. Under the circumstances the stronger get the lion's share while nestlings which are congenitally weaker, or less strong because they have been hatched later, get shouldered aside and get little of the food. There are some interesting adaptations on the part of the nestlings which help to make feeding easier. It has been suggested that the bright colouring of the inside of the mouths of the nestling birds helps the parents, particularly in dim light, to locate the mouths of their offspring. If the theory is correct it is easy to see how such a helpful character would become readily established by the survival of the birds possessing the advantage and the extinction of those who do not. EDS.]

XXIII.—NOTES ON BIRDS IN BALUCHISTAN

On April 5, 1929, at about 10,200 feet, I saw a pair of Scarlet Minivets (*Pericrocotus speciosus*) on the crest of the Kaisarghar Range, which is the western half of the Takht-i-Suliman massif. They were moving very slowly along the crest, so (as it is the provincial boundary) sometimes in Baluchistan, sometimes in the North-West Frontier Province. They were evidently looking for a nesting site in the Chilgoza Pines (*Pinus longifolia*) which grow there in profusion, and spent a good quarter of an hour within a dozen feet of me in the tree above my head. These birds have not previously been recorded from this part of India.

Then, in August, I saw many Black Tits (*Lophophanes rufonuchalis*) at Shinghar, at 8,000 feet. This bird is also not recorded from Baluchistan. They appear to be a new race[1], lacking the buff spots on the wing, and I have sent a specimen to the Society, together with a Rock Nuthatch (*Sitta tephronota*) from the same hill. Both these skins were a good deal knocked about, I regret to say, as I only had No. 5 shot.

Other birds of note which I have seen are White-necked Storks (*Dissoura episcopa*) of which only one specimen is recorded from Sind, and, as far as I can ascertain, none from Baluchistan. I saw five of these birds at Murgha for several days in the first half of last March. (Forty or fifty Green Plover, were with them.) I saw fourteen of these storks on March 2, 1930, and nine the previous Sunday, on the Zhob River five miles from Fort Sandeman.

Several hundred pelicans were driven down on to the hills between Ziarat and Loralai by bad weather in February, 1929, and many were killed with sticks by local Pathans. They would appear to have belonged to the species *Pelecanus crispus*.

I have also to note the arrival of a flock of about thirty Common Teal at Murgha on August 2, 1929. This I think is the earliest arrival date on record. They were there for 24 hours and local Pathans stated that they, or another flock, had been there for the two previous days, in the same flooded fields.

FORT SANDEMAN, C. H. STOCKLEY,
March 8, 1930. *Lt.-Col.*

XXIV.—OCCURRENCE OF THE WHITETHROAT (*SYLVIA CURRUCA HALIMODENDII*) IN THE PUNJAB

On December 9, 1928, I secured a solitary Whitethroat which was haunting some *Farash* trees (*Tamarix articulata*) outside the Rest House at Roda in the Shahpur District (Punjab). Roda is situated in the *Thal* (desert) area between the Jhelum and the Indus. This bird, a male, has now been identified by Mr. H. Whistler as *Sylvia curruca halimodendii*, a Central Asian race of

[1] The bird in question was submitted to Dr. C. B. Ticehurst for examination who states that the bird obtained by Col. Stockley is a young example of the above-named Tit. EDS.

the Lesser Whitethroat. Mr. Whistler informs me that there is no previous record of this race from India proper, but that Hotson collected a female on the 31st January 1917 at Nur Mahomed, 22 miles north-west of Chaharbar in Baluchistan. He adds that in colour it is very similar to *minula* but is larger, the size of *affinis*.

RAWALPINDI, PUNJAB, *April 8, 1930.* — H. W. WAITE, *Indian Police.*

XXV.—THE AMANDAVAT (*AMANDAVA AMANDAVA*) IN MESOPOTAMIA

Captain H. F. Stoneham of Kenya Colony has recently sent me two wings of a supposed warbler which he obtained at Baiji in 1918 and which he had put away and forgotten about. These wings are certainly not warbler's wings and correspond exactly with those of a juvenile Amandavat (*Amandava amandava*).

On further correspondence he writes 'The wings from Baiji are absolutely authentic. I remember the occasion and so you can rely on the record with absolute certainty. There were several birds about . . . in some long grass between cultivation and the river'.

It is of course possible that amandavats have been introduced into Mesopotamia as they have elsewhere. Information about the species in Mesopotamia is desirable.

APPLEDORE, KENT. — CLAUDE B. TICEHURST.

XXVI.—OCCURRENCE OF THE WHITE-HEADED OR STIFF-TAILED DUCK (*ERISMATURA LEUCOCEPHALA*) IN THE N.W.F.P.

A party of three guns, Mr. J. G. Dunn, Mr. S. Weller, and myself left Wazirabad at about 5.30 a.m. and proceeded *via* Khanki to a place known as Garjargola. Last year this spot had given us some very good sport.

We arrived there to find that there was next to no sport to be had as the water had almost vanished.

From Garjargola we went about another ten miles further along the Lower Chenab Canal looking for duck, and eventually shot one Gadwall and one Teal. Owing to the scarcity of sport we decided to return to Khanki and try some flighting on the river.

We must have arrived at Khanki near 4 p.m. and walked along the head-works making enquiries regarding the shooting to be had. A workman pointed out two birds swimming in the backwater caused by the closing of the sluices. The birds were ridiculously close in, and watching them I said that they were Grebes. We must have watched them for nearly one hour. They would swim up to the current, hold steady there for a couple of minutes and then return to the slack water near the sluices. They swam very low in the water, with their tails raised, and heads placed low on the back. Once again I said that they were Grebes, but Mr. Weller

said that he was rather doubtful. We managed to procure a boat soon after, and the birds refusing to be put up were shot at by Mr. Dunn. One died and the other apparently wounded flew for a couple of yards, settled and at once dived. It came up again in almost in the same spot after some thirty seconds. I at once shot it. When the birds had been recovered we at once saw that they were out of the usual run of duck found in these parts. On the way home their name came to me and I knew that we had come across a rare visitor to India. Reaching home they were identified as the White-headed or Stiff-Tailed Duck from 'Indian Ducks and their Allies' by Stuart Baker.

I wrote to the *Civil and Military Gazette* asking them to publish a short paragraph recording the shooting of these birds.

WAZIRABAD, T. D. WEEKS.
November 23, 1929.

XXVII.—OCCURRENCE OF THE STIFF-TAILED DUCK (*ERISMATURA LEUCOCEPHALA*) IN THE SHAHPUR DISTRICT, PUNJAB

I have much pleasure in sending you by post to-day a specimen of a Stiff-tailed Duck (*Erismatura leucocephala*), shot at Sarghada, Shahpur District on February 7, 1930. Capt. Taylor and myself bagged 2½ brace. I have personally only once before come across a specimen in the North of India in the Mianwali District and this appears to me to be an unusually large bag.

NOWSHERA, N.W.F.P., W. E. FLEMMING,
February 10, 1930. *Lt.-Col.,*
3/17 Dogra Regiment.

XXVIII.—OCCURRENCE OF THE MALLARD (*ANAS PLATYRYNCHA*) IN UPPER BURMA

I enclose the skin of a Mallard duck shot by Mr. Turner, Divisional Forest Officer, Bhamo. He also shot one in 1926.

BHAMO, A. J. JONES,
January 13, 1930. *Imperial Police.*

I am sending you two skins of Ducks under separate cover. One is a drake Mallard which was shot by Mr. H. F. Burke on December 30, 1929, on Menkalee Jheel in the Upper Chindwin, Burma. There seems to be no doubt as to the identity of this bird but in view of its very rare occurrence in Burma we should like it verified and think it may be of interest to you.

MAWLAIK, N. THIRKELL WHITE.
January 6, 1930.

[The birds referred to in the above notes have been identified as Mallards (*Anas platyryncha*). The Mallard is very rare winter visitor to Burma. EDS.]

XXIX.—OCCURRENCE OF THE BAIKAL TEAL (*NETTION FORMOSUM*) IN THE DURBHANGA DISTRICT, N. BIHAR

I am sending the Bombay Natural History Society one skin of a strange duck shot by me yesterday in the Somastipur Subdivision of Durbhanga District, North Bihar for identification and retention if so desired.

H. R. DUTTON,
Lt.-Col., I.M.S.

January 20, 1930.

[The teal submitted to us for identification is an example of the Baikal or Clucking Teal (*Nettion formosum*), a rare winter migrant to India. EDS.]

XXX.—BATHING HABIT OF THE INDIAN ROLLER (*CORACIAS BENGHALENSIS*)

In November last while boating at about noon on the Jumna at Allahabad, I noticed the bathing behaviour of a Roller, commonly known as the Blue Jay, which appeared rather novel. As is its wont, the bird was perching in a prominent position on a bamboo post on the bank of the river. Presently I saw it sally forth and make straight for water into which it dived. My first impression, on seeing this behaviour, was that the bird espying a quarry had gone out in its usual manner to catch it, and had had to dive in the attempt. Since there appeared to me no insects about, it appeared likely that the objective was a small fish. I was, however, not aware that these birds ever preyed on fish, and my curiosity was therefore naturally aroused. I then decided to observe more carefully the next performance of the bird in case it repeated it. In this I was not disappointed. Soon the bird launched forth again, and dived as before. When it emerged I could clearly see that there was nothing in the beak, and it was apparent then that the bird was enjoying a bath. In the mean time our boat was gradually approaching the spot and I began to fear that it would take fright and fly away. But the Jay appeared to be too much engrossed in its own affairs to be disturbed by these considerations. Again and again it took off and dived within a few yards of us. After seeing this performance, repeated a number of times, at very close quarters, I had not the least doubt that the bird needed a bath very badly, and it availed itself of the water of the river for this purpose in the absence of any other available water-supply in the neighbourhood. In diving, the bird would enter the water obliquely and just enough deeply to become completely submerged. It would soon emerge, carried through by its own momentum, and return to its perch.

I give these details in the hope that if not known they may be recorded.

BENARES HINDU UNIVERSITY,
February 5, 1930.

N. K. TIWARY.

[In Volume XX of the Society's Journal, page 225, Major H. Delmé Radcliffe describes a similar behaviour on the part of a

Burmese Roller which dived head first into a tank and after being momentarily submerged flew up to its perch. The bird repeated the operation 4 times. The author of the note presumed that the roller was catching its prey in the water. In the same volume, page 853, Mr. Gordon Dalgliesh refers to a letter written by him in the *Field* in which he commented on a Roller hovering over water and plunging headlong into the stream. Neither of the writers had seen the bird return from its plunge with its prey in its mouth. The dive and the momentary submersion is evidently the bird's method of taking its bath. Other birds we have observed bathing in this way are the King Crow and the Indian Oriole. EDS.]

XXXI.—NIDIFICATION OF STORKS

(*With a photo*)

The White-necked Stork (*Dissoura episcopa episcopa*).

On the 18th of October last I came upon two nests of this stork on a Babul Tree (*Acacia arabica*) growing in the middle of an artificial lake, which is dry during the hot weather, at Abu Road. One of the nests was empty while the other had two fully-fledged young in it. One of them flew away when I got up the tree. I captured the other which, in spite of the hacking of the branches and breaking up of the nest, made no attempt to escape, but remained sitting low in the nest. The nests were composed of twigs of the same tree, about three feet six inches in diameter. The centre was lined with a little grass and other rubbish. In depth it was deep enough to hide the bird when sitting close. Both parent birds were at the nest when I got to it but they flew off making no attempt to defend it.

Regarding the young birds the 2nd edition of the 'Fauna of British India' (Birds) says :—'Young birds have the glossy black replaced by dull brown, unglossed'. The colouration of the specimen obtained by me agrees with the description of the old bird. There was no dull brown about it and the gloss was distinctly present.

This young bird I kept in captivity for almost a month and handed it over to the local Zoo on my return to town. It became quite tame and fed from my hand. Its food consisted of fish, and mice when obtainable.

The only sound I heard this bird utter was a humming, much like that of a bear when sucking its paw. This it uttered whenever it saw me in the compound and whenever I approached it, bobbing its head repeatedly as if 'filling the bellows' each time it started it anew. Besides this it would 'drum' with its bill, like all storks, when alarmed by a dog or other animal. Frequently it would attack an animal if it approached too near.

The Black-necked Stork (*Xenorhynchus asiaticus asiaticus*).

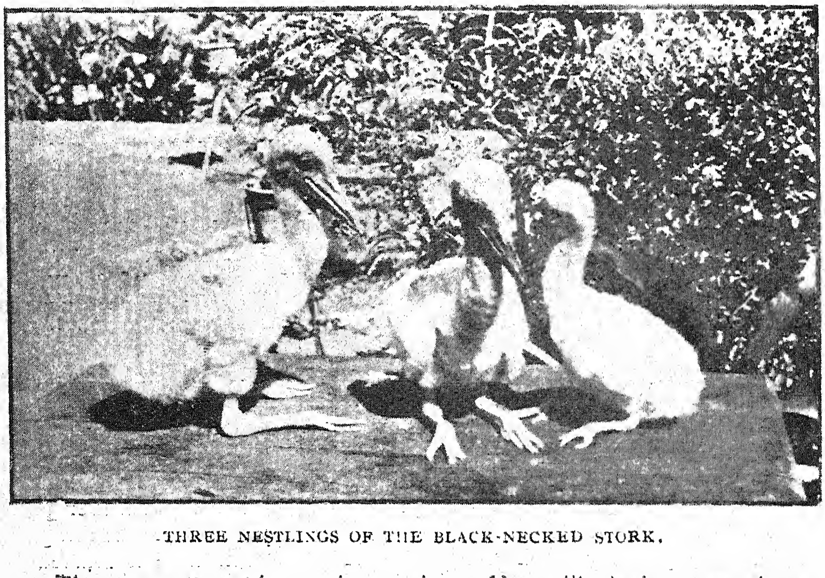
On the 14th of September last my brother-in-law discovered the nest of this species with two eggs in it high up on the top of a large Banyan (*Ficus indica*). On the 17th October I visited the spot and

found that it contained three young and one egg. The birds were very young and covered in short white down. I took the young and the egg. When I blew out the egg I found it to be quite rotten.

The nest was large, about 7 ft. in diameter, composed of twigs of a species of *Zizyphus* which was very common in the neighbourhood. The central portion was lined with straw and pieces of rags for about two feet in diameter. The nest itself was comparatively shallow and strong enough to bear the weight of a man.

When I reached the nest the parent bird was sitting in it. What surprised me most when I approached was, that though this bird was armed with such a powerful bill it did not attack, though I fully anticipated having a bad time. When I got up to the nest which was about 75 ft. from the ground, the parent bird just moved off to the periphery of the nest clapping its bill loudly and looked most aggressive but as soon as I came nearer it flew away, circled round the tree a couple of times and then went away and sat on a tree some distance away and watched the proceedings.

On my return past the same tree about half an hour later the bird was back at the nest. Days after when I passed the same spot I saw the bird at its nest again and on the 13th November when I left for Bombay, the train passed the spot, I looked out and found this bird at its nest again. I never saw the mate.



THREE NESTLINGS OF THE BLACK-NECKED STORK.

The young proved very interesting. No quills had appeared at this stage. The white down of the neck gradually disappeared about three or four days later and was replaced by a dark blackish-grey down from beneath, the white down crowning the black here and there. In about ten days the white down of the neck had disappeared completely. About the same time when the colour of the neck changed the scapulars began to sprout. These were the first quills to appear. A couple of days later the primaries began

to show themselves and then the other wing quills. The scapulars grew much faster than any of the other feathers, the primaries following next. The next feathers to appear were those leading from the scapulars towards the neck. All this time the down of the body had got much deeper.

The young feed readily by themselves on fish, cut up small, this proving that the parent birds must regurgitate the food they have brought into the nest for the young to pick up for themselves. The young would gorge themselves to such an extent that they would be full to the top, so much so that they were unable to keep their necks up. Frequently, if the fish was not satisfactorily packed in the gullet it would be brought up and reswallowed, if one of the others did not get it before the one engaged in the rearrangement.

The legs were fleshy white. About ten days after their capture they commenced to stand upright on their legs, only for a short while, from time to time, by way of exercise, otherwise they always rested in the usual sitting posture, 'stork fashion'.

The only sound the young made was first a sort of 'chack' followed by a 'wee-wee-wee' repeated two or three times. When they were approached and aroused from their sleep they would immediately get up stretch their necks and 'drum', to be followed by the sound described above.

They readily recognized the difference between man and animals even at this early age, for when the dog approached they would stand on their dignity, spread their little wings and launch out at the dog with their bills.

Unfortunately a couple of days before I left for Bombay something went wrong with them and the three died, thus leaving my notes incomplete.

Another nest of this species was discovered on the very top of a Tamarind tree (*Tamarindus*). The bird was sitting, but the nest was empty, presumably she was about to lay as she returned to it. This nest was visited on the 11th November.

So far as my observations go I have always found these birds feeding on the river during the day and late in the evening in fields not too far from a village, where it is possible they roost for the night. I have always seen them about in pairs when feeding.

On one occasion I was fortunate in getting two of these, the pair, in one shot, both were wounded and put up a big fight when I tried to capture them, drumming loudly all the while. While I was engaged trying to get hold of the wounded ones, another pair appeared in the sky and circled over the wounded ones also drumming all the while, but after investigating the cause of the alarm raised by the wounded flew away.

The wounded ones ran very fast but could not maintain the speed for long—100 yds. being their limit, after this they would turn round and face the enemy.

BOMBAY NATURAL HISTORY SOCIETY, C. McCANN,
BOMBAY, *Assistant Curator,*
November 28, 1929,

XXXII.—NESTING OF THE SARUS (*ANTIGONE ANTIGONE*)

The following are details of a Sarus' nest found about October 5th. The nest consisted of a raft of rushes roughly 4′ square, floating in about 3′ 6″ of water. The nest contained one fresh egg $3\frac{3}{4}''$ long.

CAWNPORE, A. J. R. HILL, R. E.,

November 23, 1929. *Lieut.*

XXXIII.—FISH-EATING HABIT OF THE SARUS CRANE (*ANTIGONE ANTIGONE*)

Does fish constitute any part of the dietary of *Antigone antigone antigone* (Linn.)? In an exhaustive article on the Game Birds of the Indian Empire published in *J.B.N.H.S.* (Vol. xxxiii, 4), Mr. Stuart Baker writes 'their food consists of all kinds of grain, shoots, aquatic plants, frogs, lizards, insects, etc., and they feed alike in shallow water up to 18 inches deep and in cultivated field and open plains'. In the latest edition of F.B.I. also he makes no mention of fish while referring to food habits of these cranes. His reticence is rather deplorable, as it tends by implication to set at naught the previous records of Blanford, Hume and Marshall bearing on this point. Jerdon spoke of the *Gruidae* 'feeding much on grain, a few also on insects, frogs, and fish (B.I., Vol. iii, 661)'. So too Blanford in F.B.I. (Birds) iv, 185—'Cranes are in the main vegetable feeders, though they occasionally eat insects, reptiles or fish'. In Hume and Marshall's 'Game Birds' (Vol. iii, 25-27), mention is made of remains of small fish being found occasionally in the gizzards of the Common Crane. Mr. Stuart Baker speaks of the latter as omnivorous, but when one takes note of the diverse items mentioned by him which enter into the composition of dietary of *Antigone a. antigone* (Linn.), it is difficult to think of the Sarus otherwise than being omnivorous. Besides the nature of its haunt and habitat does not appear to preclude the possibility of its preying on shallow water fish, should one come in its way, in the trail of a host of other live objects. In Hume and Marshall's 'Game Birds' (Vol. iii, 4-5) we read—'The food of the Sarus is very varied, frogs, lizards and all small reptiles, insects of all kinds, snails and other land and water shells, seeds, grains and small fruits of various kinds, green vegetable matter and the bulbous roots of various species of aquatic plants . . . . ; and they seem to feed indifferently in wet and dry fields or dry grassy uplands, on the margins and in the shallows of rivers, broads and swamps. . . . They feed a great deal on the young paddy plant, and sometimes do considerable damage in the nurseries . . . probably they do also eat other green shoots, grasshoppers and frogs, and perhaps young fry'. That the Sarus has a predilection for fish and exhibits a propensity for catching live fish if kept in a vessel of water is borne out by my experience of a bird which I bagged alive during my bird collecting

expedition in Bareilly District in November 1928. While feeding on the edge of a pool of water beside the paddy field of a village near the Ramganga River, about 4 miles away from the Cantonment of Bareilly I took it unawares with my 12-bore gun; it being hit on the leg and thigh, I captured it easily. It became surprisingly docile after I managed to dress the gun-shot wound. Of the various foods I placed before it (viz., grains, leaves, boiled rice, bread crumbs, fish, etc.), it would appear to like catching, and with its long bill taking out, from an earthen water-vessel, live fish. It would raise its neck and bill upwards and with a jerk throw up the fish only to gulp it down its throat. In a short time, its wound having healed up completely, the bird became so confiding as to step up all available spaces round my habitation and frequent a particular spot where fish for my domestic consumption used to be daily prepared for the kitchen. Nor was it a mere silent spectator; it would stalk up very near the person preparing the fish, and make bold in his very face to lift one after another and gulp down as many of the fish as it was allowed to do. It would even look into the bucket where live fish like *Magur* (*Clarius magura*) was stocked for next day's consumption and pilfer those that came within its reach.

I find records of the fact that in captivity the Sarus develops a taste for fish. Hume and Marshall in their 'Game Birds' (iii, 5) speak of young Sarus, which, 'when domesticated are often fed by the Burmans on small fish and shrimps'. This is as it is expected of a bird which is omnivorous in its habit, but when one finds a wild Sarus immediately after its capture behaving with regard to its food in the manner I have observed, the irresistible conclusion is that in its wild state fish forms one of the items, however negligible, in its varied menu.

CALCUTTA, SATYA CHURN LAW.
February 11, 1930.

XXXIV.—PEAFOWL WITHOUT A TRAIN
A Burmese Belief

The Peafowl I sent you were shot on January 12, 1930, at Mônnyin on the Mon River in the Minbu Forest Division. The cock without the train weighed 9½ lbs. and was one of a covey of about six birds none of which as far as I could see had a train. When I had shot this cock I remained quiet in some rather thick jungle and the rest of the covey came quite close uttering a peculiar note somewhat resembling Tak-tak-ker-r-r-roo-oo, ker-r-r-roo-oo—quite softly as they walked about apparently in search of the dead cock. I then shot the hen sent herewith after which the rest of the covey departed.

The local Burmans, as soon as they saw this cock, which I took merely to be a young bird without a train, said it was a *haing*, some calling it a *Pago-daung* as distinct from an ordinary *daung* (Burm. :—peafowl). A *haing* is the Burmese name for a *mukna* or tuskless male elephant and the Burmans say that there are certain *haing* peafowl which never grow trains and never utter the typical

trumpet call just as there are *haing* elephants which never grow tusks. This may be a well-known fact but I have never heard it mentioned before nor have I heard the peculiar noise uttered by the peafowl of this covey.

On January 13, 1930, I shot the cock with the train out of a covey of about six within $\frac{1}{4}$ mile of the place where I killed the other birds the evening before. It weighed $11\frac{1}{4}$ lbs. and was the only bird with a train in the covey which seemed quite normal.

MAYMYO,
March 8, 1930.

H. C. SMITH,
Deputy Conservator of Forests,
Game Warden, Burma.

XXXV.—AN ENORMOUS ESTUARY CROCODILE (*CROCODILUS POROSUS*)

One occasionally comes across specimens by hazard that must have some interest to some of your readers. In this small but ancient city we possess a Museum—excellent of its kind. I had recently occasion to visit the Museum and found under the stairs the skull of an enormous crocodile (*C. porosus*). The dimensions are as follows:—

Total length	37 inches
Greatest width	$18\frac{1}{2}$,,
Height	$12\frac{1}{2}$,,
Weight without teeth	54 lbs.

Being much the largest skull I had ever seen I wrote to the British Museum. Mr. M. W. Parker of the Reptile Department was interested and sent me a reply in some detail. The largest skull in the British Museum is $36\frac{1}{2} \times 18\frac{3}{4} \times 12\frac{1}{2}$ inches therefore somewhat smaller than the specimen here. The largest Mr. Parker knows of is mentioned by Barbour in his book 'Reptiles and Amphibians'. It is in the Museum of Comparative Zoology, Havard. The skull of this specimen is 39×19 inches. It is estimated that the Elgin specimen must have been about 27′ long with a girth of 12′. As *Crocodilus porosus* occurs along the estuaries of the East Coast of India, in Bengal, Burma and Ceylon perhaps further data concerning the dimensions of this crocodile will be forthcoming. Perhaps this will catch the eye of some of your readers possessing large crocodile skulls or correct measurements of these reptiles in the flesh. Any data from which formula can be derived to indicate the probable size of the animal from the dimensions of the skull would be of great interest.

ELGIN, SCOTLAND,
October 20, 1929.

A. A. DUNBAR BRANDER.

[The following are dimensions of two large skulls of *Crocodilus porous* kindly sent to us by Dr. Baini Prashad, Indian Museum. Calcutta. Dr. Prashad writes.—'I give below the measurements of the biggest skull of *Crocodilus porosus* in the Indian Museum

Collection as well as those of one in the United Service Club, Calcutta.

		U. S. Club		Indian Museum
Total length	...	33½ inches	...	38 inches
Greatest width	...	16 ,,	...	18½ ,,
Height	...	11½ ,,	...	13½ ,,
Weight	...	...	...	54 lbs.

EDS.]

XXXVI.—NOTE ON SNAKES COLLECTED AT BELGAUM

It might interest you to have a record of the few snakes collected by me at Belgaum, where I was Civil Surgeon from October 1927 to June 1928. During this period, 19 snakes were seen by me and identified. These are :—

		No.
Sylibura phipsoni.	... ...	3
Lycodon aulicus.	... ...	5
Macropisthodon plumbicolor.	... ...	7
Vipera russellii.	... ...	1
Callophis trimaculatus.	... ...	1
Zamenis mucosus.	... ...	2
		19

13 of these were found in the Civil Hospital and its extensive compound of about 25 acres and two in the bungalow I was living in, No. 17 Fort. No special attempts were made to collect snakes from the town or from Cantonment limits.

1. *Sylibura phipsoni.*—Two of these were seen in hospital garden and one in the garden of the bungalow of the Executive Engineer, Belgaum, in the Fort. All these were seen during the day in the mornings before 12 noon.
2. *Lycodon aulicus.*—One was seen near a hospital ward, two near the hospital staff quarters and two in my bungalow in the Fort. All were seen during night time. One was killed inside my bungalow in the dressing room at 8.15 p.m.
3. *Macropisthodon plumbicolor.*—Four of these were found in the hospital compound and two near wards. All these were seen during the day.
4. *Vipera russellii.*—One fresh well-marked specimen was seen and killed, lying coiled behind the open door of the male septic ward in the hospital at 3 p.m.
5. *Callophis trimaculatus.*—The snake was sent to me on November 19, 1927 by the Medical Officer at Gadag on M. & S.M. Railway, Dr. K. B. Lele, who worked under me at Sholapur and knew I was interested in snakes. This snake, not being a common one, was sent to the Bombay Natural History Society. Curiously enough, this same Medical Officer saw another live specimen of this species on the foot-path opposite the J. J. Hospital,

Bombay, in the morning on August, 1928, and brought it to me as I happened to be in Bombay then. I took it over and gave it alive to the Natural History Society Museum the same day.

It is interesting to note that no cobra, though considered a common snake everywhere, was seen. I wonder if the red laterite soil and elevation of Belgaum (about 2,300 feet above sea level) are not favourable conditions for the occurrence of this otherwise unfortunately too common a snake.

AHMEDNAGAR, K. G. GHARPUREY,
March 7, 1930. *Lt.-Col., I.M.S.,*
Civil Surgeon.

XXXVII.—LOCAL NAMES OF SOME FISH FROM THE TEESTA RIVER

Specimens of several species of dried fish, with a list of local names, were received through the kindness of Mr. M. Pradhan, Deputy Magistrate, Kalimpong. The animals were all collected from the Teesta River. They were dried as usual, after the abdomen had been cut open and the abdominal viscera removed. Although dried, the specimens did not present much difficulty in identification.

Barilius bendelisis (Ham. & Buch.) var. *cocsa*—Pakhetay (Pakhete).

Barbus tor (Ham. & Buch.)—Kataley (Lamo) (Katale).

B. dukai Day—Titey Buduna (Buduna).

Exostoma blythii Day—Buduna (Buduna).

Pseudecheneis sulcatus Mc Clelland—Kabray (Kabhre) two colour variations are recognized: One, Pangray Kalo Kabray (that is, black-spotted) and secondly, Sonoulay Kabray (that is, golden-coloured). The specimen of the first form is slightly darker above and more yellowish than the other which is of golden colour and less black above.

Semiplotus macclellandi, Bleeker (better named *Semiplotus semiplotus* Mc Clell.)—Cheptee (Cepti).

Nemachilus montana Mc Clell.—Gaderah (Gadera).

N. multifasciatus Day—Bam Gaderah (Bam Gadera).

Schizothorax progastus Mc Clell.—Asalah (Asala).

Ophiocephalus stewartii Playfair—Hilay (hile). Two colour variations are seen in the specimens: One with a greenish dark yellow colour is called Hario (green) Hilay; the other yellow in colour, but lighter than the first, is called Phusro (brown) Hilay. Evidently the natural colour has faded to a certain extent.

MEDICAL COLLEGE, EKENDRANATH GHOSH, M.SC., M.D.,
CALCUTTA, *Professor of Biology.*
February 5, 1930.

XXXVIII.—MASHEER FISHING IN THE ZHOB RIVER

Heavy floods on the Zhob River brought up a fine run of mahseer. The previous record fish from the Zhob was a trifle over eight pounds, but in January 1930, two officers fishing a little below Moghulkot, caught 140 lbs. of fish in a morning, including one of 15 lbs. This natural re-stocking of the river is a great boon, as very severe frosts at the end of January 1929 killed most of the small fish, sacks full being brought into Fort Sandeman for sale.

FORT SANDEMAN, C. H. STOCKLEY,
March 8, 1930. *Lt.-Col.*

XXXIX.—NOTES ON *PARANTIRRHŒA MARSHALLI*

Since I sent a note on this butterfly in May 1928, I have obtained a copy of Col. Mander's description of the ♀. He states that the ♂ described by Wood-Mason was caught in May, and the ♀ in October; and, quoting Mr. William Hockin, to whom he was indebted for the loan of the butterfly for description, says that in Travancore, where it is found at the foot of the hills or between that and 3,000 feet, 'it is found only on Itah (small hill bamboo) in drizzly weather in October'.

Apparently 'Itah', though in Brandis the name Ita Kalli (Tamil) is given to *Ochlandra travancorica,* is the same as the Coorg 'wate' (*Ochlandra Rheedii*). *O. travancorica,* which occurs also in Coorg, I believe, grows about 2,000 feet (Brandis). Whereas *O. Rheedii* grows near rivers and streams from the low country to 3,000 feet. It is not a bamboo, but resembles a reed.

Thus, previous to its capture in Coorg, this fly was recorded as found in Travancore in the months of May and October. I am able now to record that I have caught it in every month from September to May. Mr. P. C. Uttaya has, since I left India, I believe, got it in June before the monsoon broke. As to the monsoon months, July and August, I have as yet no information. I add that I caught fresh specimens every month. On the whole, however, the butterfly is more frequent in the months, April-May and September-October, which coincide with the periods of the early rains and the cessation of the heavy rains respectively.

The suggestion that the butterfly can be had 'in drizzly weather'—? only drizzly weather?—is, I think, a mistake. It is perhaps true to say that the ♂ is readier to come into the open during the day-time in damp weather. But it can be caught within the 'wate' grove on any sort of day, even in the brightest weather, if beaten out of its hiding; and in any case both ♂♂ and ♀♀ fly at dusk, whatever the weather. I have caught it from 8 a.m. till 7 p.m., and in all weathers ranging from actually wet to absolutely rainless.

Though the ♂♂ come into the open in the day-time during dull damp weather, flitting across a glade or a road from one grove of 'wate' to another, I do not think they really fly then. There is then no activity in their flight: often it is merely a case of escape from some disturbing influence; they go from one hiding place to

another, and having flitted make use of their protective colouring to conceal themselves. I remember that on one occasion a servant who was beating the 'wate' with me, started a ♂ from the top of a clump of 'wate' some 20 feet in height: it floated down and settled on dead 'wate' leaves, where it lay still, indistinguishable to the casual glance from its surroundings. I put my net over it but it would not move. In the end I lifted the net and picked it up with my fingers to put it into a slip.

Both ♂♂ and ♀♀ fly at dusk. We observed that in the late afternoon the ♂♂ were difficult to move, but that the ♀♀ tended to come from the deeper and darker parts of the grove to the clumps on the edge. Just after sunset the ♀♀ rose and floated about near the top of the 'wate' and were visible against the sky. Later, about ten minutes before it became too dark to see them, they flew at a height of four to five feet from the ground near the edge of the grove, in and out and round the clumps, about the same time the males rose and flew, often in couples, chasing each other round, in the open spaces between the clumps of 'wate'. On several occasions with one sweep of the net we caught two ♂♂ flying in this manner. The time of their flight, we noticed, coincided with the appearance and chirping of a small bird, which flew or hopped about the top of the 'wate' clumps: it was evidently waiting for the flight of *Parantirrhœa* and possibly of other dusk-loving butterflies. At any rate on one occasion we saw a *Parantirrhœa*, which we were watching as it flew high up in the 'wate', seized by one of these birds.

This flight of the ♂♂ we took to be a sort of marriage dance. The ♀ flying in and out of the clumps would attract the ♂♂: it was only at this time of the evening, when it was nearly dark, that we saw and took, though not at one stroke, both ♂ and ♀, the one pursuing the other. It was only during these few minutes between dusk and dark that we saw ♂♂ and ♀♀ together.

I record that we had little difficulty in telling a ♀ in flight. Apart from the time and manner of flight, we could tell it by (*a*) its greater size, (*b*) its lighter colouring, which even in the late dusk was obvious. It's whitish spots often made it clearly distinguishable.

In April last, Mr. P. C. Uttaya and myself twice took ♀♀ and endeavoured to mate them with ♂♂ but without result. On each occasion both ♂ and ♀ died leaving no issue. Mr. Uttaya, now that I have left India, is making further efforts to get larva and pupa of *Parantirrhœa marshalli.*

BERKHAMSTEAD, J. A. YATES.
November 8, 1929.

[*Note.*—I had recently learned that Col. Fraser has taken *P. marshalli,* by beating the 'wate,' at the top of the Vayatri Ghat, from Calicut to the Wynaad. My supposition that the butterfly would be found in the valleys between Travancore and Coorg appears to be justified. It will be found, I think, that it is not *very rare*, but, if not common, at least *not rare*, wherever 'wate' grows. It would be interesting to discover its northern and southern limits. J.A.Y.]

XL.—NOTES ON *PATHYSA ANTIPHATES NAIRA*

This butterfly, in the books I have seen, is described only in the wet season form. In the British Museum it is poorly represented and only by the W.S.F. I do not know if the D.S.F. is described anywhere, in some back number of a journal or magazine. Even if it is, I think a note on the butterfly in Coorg may be of interest.

1. Early in the day it flies in glades and openings in the forest, usually rather high, settling from time to time on flowering trees. But from about 11 a.m. onwards it acquires a thirst and comes down to damp patches on the roads—as where a motor-car or bus has watered up—or on the edges of streams or rivers. Its thirst appears to be considerable; once it has settled it is not easily driven away; thus it may settle among a crowd of Pierids, which on the approach of a human being with a net rise and scatter, leaving *P. antiphates naira,* which remains unmoved, greedily sucking moisture, an easy prey. Occasionally several will settle at the same spot; I have had as many as five in the net at once.

2. It is to be caught all through South Coorg in the neighbourhood of the ghats, both above and below the ghats, where the forest is evergreen. It is to be had near Srimangala under the Brahmagiri Hills, round about Hapoklu, on the Kakkotpole crossing into Marinad and at Appugala below Mercara; but it is commoner on the ghats, as on the Mangalore (Sampaje) and the Tellicherry (Periambadi) ghat roads, and on the Paiyaswani and Urti rivers.

3. It is evidently to be had from December to the end of May. The form described in the books is the later or wet season form, which seems to appear in March and to continue till just before the break of the monsoon. Earlier, i.e., from December till mid-March, the butterfly passes through changes from an extreme dry season form, in which the characteristic broad grey band (*vide* Evans' Identification of Indian butterflies A. 5. 6 B) is completely absent, through intermediate forms, in which the grey tornal area spreads and widens from the neighbourhood of the tail, until the full wet season form arrives.

I give below a short list of variants and the dates of catches in 1928 and 1929. It will be seen that the intermediate forms, as might be expected, overlap :—

(1) Dry season form; no grey tornal area
27-12-28
13- 1-29
15- 2-29.

(2) Form in which the grey area is incipient.
22- 2-29 (two specimens)
5- 3-29.

(3) Patch of grey spreading more widely inwards from the tail, but still some way from the costa.
20-2-28
17-2-29
20-2-29 (three specimens)
11-3-29.

(4) A form intermediate between (3) and the next: 18-3-29.

(5) Nearly full grey, but the band from above the tornus to the costa not so wide nor so dark as in the next (6).
22-2-29
10-3-29 (two specimens)
16-3-29.

(6) The full and typical wet season form. First caught on 18-3-29; after which the intermediate forms disappeared.

4. In type (1), the upper hind-wing is white, but the chrome colouring of the underside shows through. The terminal black edging is narrow, and the sub-terminal black lunules are just traceable. The change to full W.S.F. is by the gradual spreading of the grey patch from the tail both towards the tornal black spot—towards the costa. The lunules became larger and darker in W.S.F., and the grey band a much darker grey, which is distinctly blackish towards the costa.

5. With regard to the upper fore-wing in the D.S.F., the black bands are generally narrower and shorter than in the W.S.F.

(1) The basal band barely touches the dorsum and the lower half is faint. (2) The sub-basal band is distinctly short and interspace faint, being grey rather than black. (3) The fourth bar touches the 'median vein' only in the W.S.F. In the earlier D.S.F. forms it extends only half-way, from the costa to the 'median vein' and ends in a point. (4) The post discal and terminal bands coalesce at v 4, but do not reach the tornus; they end in a point between vv 1 and 2.

The transition from D.S.F. to W.S.F. is a gradual lengthening and widening of the bands till in the full W.S.F. the sub-basal band ends in interspace la, and the post discal and terminal bands end not in a point but in a narrow band on the dorsum inwards from the tornus.

BERKHAMSTEAD,
January 31, 1930.

J. A. YATES.

XLI.—ON THE OCCURRENCE OF *VANESSA ATLANTA* AND *PARARGE SCHAKRA* IN BALUCHISTAN

The butterflies at Shinghar would seem to be worth extensive study, for there I took two remarkable butterflies. The first, *Vanessa atlanta* (the English 'Red Admiral') has not been previously recorded from nearer than Northern Mesopotamia; the second *Pararge schakra*, not been previously recorded from outside the Himalayas. Both these specimens I have given to Brigadier W. H. Evans, C.I.E., D.S.O., now stationed in Quetta, and they will therefore, in conjunction with his own most interesting material, be dealt with later by our greatest authority on Indian butterflies.

FORT SANDEMAN,
March 8, 1930.

C. H. STOCKLEY,
Lt.-Col.

XLII.—OCCURRENCE OF *COLIAS HYALE HYALE* AND *PIERIS CANIDIA INDICA* IN THE PLAINS

On the 23rd February last, I captured a male *Colias hyale hyale* flying over a field of gram, beside the Bari Doab Canal, about 15 miles from Amritsar in the direction of Pathankot.

On the same day and near the same place I also took a few specimens of *Pieris canidia indica.*

I was unable to revisit the spot until the last Sunday in March, when I found *Colias hyale hyale* flying in fair numbers, in company with *Colias croceus edusina. Pieris canidia indica* was also again present in considerable quantities, and I have subsequently seen both species in the environs of Amritsar. Bingham gives the habitat of *canidia* as the Himalayas and the hills of Assam and Burma from 2,000 to 11,000 feet and of *hyale* as Baluchistan and the Western Himalayas, and Evans in his 'Identification' apparently also confines the occurrence of the *indica* and *hyale* races of these butterflies to the same localities, but as both *Colias croceus edusina* and *Pieris brassicae,* their close congeners, occur commonly in the sub-montane regions of the Punjab plains, it is hardly surprising that the former two should also be found in similar localities,—to which, possibly, a few individuals descend in the cold weather to continue breeding, in preference to hibernating in the hills.

Incidentally *Pieris brassicae* is extremely common in and around Amritsar at the present time and the larvae have played havoc with the climbing nasturtiums in my garden; I previously thought that they confined their attention to cruciferous plants, such as cabbages and cauliflower?

AMRITSAR, D. F. SANDERS.
April 10, 1930.

XLIII.—THE GRASSHOPPER (*ISOPSERA PEDUNCULATA*) A SUPPOSED MIMIC OF THE BLACK ANT (*CAMPONOTUS COMPRESSUS*)

In your issue of Vol. xxxiii, No. 3, pp. 497-504, is an article by Major R. W. G. Hingston on 'A grasshopper mimic (*Isopsera pedunculata*), which contains selectionist doctrine in a form that would seem to be of too dubious a nature for use nowadays.

Speaking of the similarity of the first stage nymph of the grasshopper named with the ant (*Camponotus compressus*), the author says (p. 498):

> 'What can be the purpose of this similarity? It can only be defensive. It helps the grasshopper to escape its foes. Black ants are well protected. They shoot out poison and have powerful jaws. They are very conspicuous, abound everywhere, yet very rarely are they taken by birds.'

It seems that an author should not make statements like these in defiance of existing literature. For instance in C. W. Mason's valuable work on the 'Food of Birds in India' (Mem. Dept. Agr. India, Ent. Ser., Vol. 3, 1912, p. 331) we read that:

'The ants, like the grasshoppers, are exceedingly abundant

insects and form a very large proportion of the insect food of birds in India. They are perhaps the favourite food of the Woodpeckers, Wrynecks, Rollers, and some of the Pheasants. Most birds that eat insects of any kind will almost certainly be found to take ants of one species or another.'

In the course of this publication, Mr. Mason records *Camponotus compressus* from the stomachs of thirty-six species of birds, in some of which they were found in considerable numbers. This effectually disposes of the statement that these ants are rarely taken by birds.

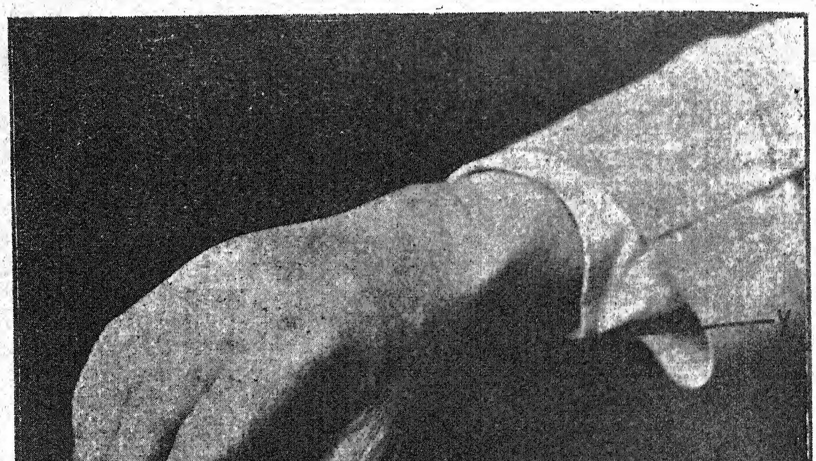
W. L. McATEE,
In Charge,
Food Habits Research.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
WASHINGTON, D. C.,
December 7, 1929.

XLIV.—EFFECT OF SPIDER BITE ON MAN

(*With a photo*)

A European resident in Rangoon was awakened during the night by feeling something crawling on his arm and hand: he brushed it off and, flashing his torch on it, saw a large yellowish spider. He felt neither bite nor pain and went to sleep. In the morning his



hand was of the normal colour but swollen to twice its size (see photo, taken when swelling had had time to subside), stiff, and with

a burning feeling along the back. At X was apparently a puncture due to a bite and, near it, a series of small pin-pricks. The hand became normal in three days. Many similar cases have been attributed to spiders but it is rare for the animal definitely to have been observed as in the present instance. It should be noted that no bite was felt and no sensation experienced until five hours later.

BIOLOGICAL DEPARTMENT,
UNIVERSITY COLLEGE, RANGOON,
February 20, 1930.

F. J. MEGGITT.

[Very little is known about the properties of the venom of spiders. Spiders being mostly nocturnal in habit and very agile often escape the observation of their victims or, if taken in the act of biting, they are destroyed, and no evidence is preserved of the species concerned. The above recorded instance would have been more valuable if the spider had been identified. All spiders possess a pair of poison glands opening near the tip of the fangs but few seem to have the power of injecting their poison into human beings. It is probable, moreover, that the poison is not automatically injected whenever the fangs are used but is under the spider's control. That popular dread of our so-called Tarantula's bite is to a considerable extent justified is proved by the following observation communicated to Dr. F. H. Gravely by Dr. Sutherland of Kalimpong (*Journ. Bombay Nat. Hist Soc.*, Vol. xxviii, p. 1045) 'A boy of 14 years was bitten by the spider (a well-grown female 'Tarantula', *Macrothela vidua*) on the finger. The pain extended up the arm, down the side after 24 hours the finger was still swollen. This spider only bites on great provocation however and this was the first instance Dr. Sutherland had known although the boys in his school frequently kept these 'Tarantulas' in captivity. Mr. R. S. Lester, on the other hand, suffered no ill-effect when bitten by a fine specimen of a much large species of 'Tarantula' (*Chelobrachys gumorus*). This may have been due to the fact that the spider, as the account states, partially emptied its poison glands during the irritation it had been subjected to previous to actually biting Mr. Lester. Drops of poison were seen exuding from the tips of the fangs. The reputation of the 'Tarantula' spider is well known; but what particular species is intended by the name is uncertain. The name is derived from the town of Tarentum and was certainly applied to a South European Spider *Tycosa narbonensis*, which has the best claim to it. Confusion has arisen through extending the name to spiders of the family *Avicularidæ* in America and the great Indian spiders of the genus *Macrothela*. EDS.]

XLV.—A YELLOW VARIETY OF THE SILK COTTON TREE (*BOMBAX MALABARICUM*)

I sent a tin containing flowers and buds of some *Simul* or Silk Cotton Tree flowers. They were quite yellow on the tree. There was no trace of pink about the blooms, but a canary-yellow colour. As this appeared unusual to me in the *Simul* when all the trees

around bore the usual flowers scarlet to pale pink in colour, I thought it worth noting. I see white flowers are noted in Brandis's 'Indian Trees' but not yellow.

TEZPUR, ASSAM, W. D. RITCHIE,
February 25, 1929. *Lt.-Col., I.M.S.*

[The flowers sent are those of the Silk Cotton Tree (*Bombax malabaricum*) but of a colour variety not so far recorded. EDS.]

XLVI.—INTRODUCTION OF THE GUL MOHUR (*POINCIANA REGIA*) INTO BOMBAY

A footnote to page 114 of Vol. i of the *Bombay City Gazetteer* says :—

'One of the first specimens of the Bengal or Royal Gold Mohur is stated to have been planted near Sewri on Waterloo Day, 1848. It grew very rapidly being 8′ high in 1854.' The species seems to have been first introduced into the island about 1845—Bombay *Times*, August 24, 1854 and June 21, 1856.

ORIENTAL CLUB,
HANOVER SQUARE, W. 1. W. S. MILLARD.

XLVII.—WHAT AGE CAN A TREE REACH?

Theoretically speaking, the life of a tree is illimited; but in reality there are many enemies which shorten the duration of its life. Amongst these there are fungus-diseases, attacks of vegetable and animal parasites, the effects of climate, disturbances of nutrition, and not least the interference of man.

It is natural that old trees having an historical interest are better known than others. When estimating the age of a tree, it is important to note that the breadth of the annual rings changes with habitat and age. Much broader rings are formed when the plant is young than later on. In some trees as e.g. the Yew it happens that stems of several individuals grow together in such a way as to make it impossible to say whether we have before us one or several trees and it is only after cutting them down that we are able to ascertain the real state of its growth.

Kerner gives the following extreme limits of age which he thinks have been calculated with fair accuracy: for the Cypress (*Cupressus fastigiata*), 3,000 years; the Chestnut (*Castanea vulgaris*), 2,000; the Oak (*Quercus pedunculata*), 2,000; the Cedar of Lebanon (*Cedrus Libani*), 2,000; the Spruce Fir (*Abies excelsa*), 1,200; the Broad-leaved Lime (*Tilia grandifolia*), 1,000; the Arolla Pine (*Pinus Cembra*), 500-700; the Larch (*Larix europæa*), 600; the Scotch Pine (*Pinus sylvestris*), 570; the Abele (*Populus alba*), 500; the Beech (*Fagus sylvatica*), 300; the Ash (*Fraxinus excelsior*), 200-300; the Hornbeam (*Carpinus Betulus*), 150 years.

The Dragon tree (*Dracæna Draco*) belongs to the Lily family. It has a tree-like stem, simple or divided at the top, and often when old becoming much branched, each branch ending in a crowded head

of lance-shaped linear leaves. The tree derives its name from a resinous exudation known in commerce as dragon's blood. There was once a colossal Dragon tree at the town of Orotava in Teneriffe. According to Meyen it was 70 feet high. Its antiquity, as Moore says, 'must at least be greater than that of the pyramids.' The trunk was hollow and could be ascended by a staircase in the interior up to the height at which it began to branch. Le Duc found it 79 ft. in circumference near the ground. Humboldt mentions that when he saw it, it had the same size (16 ft. diameter) which it had when the French adventurers, the Béthencourts, conquered these gardens of the Hesperides in the beginning of the 15th century. Unfortunately it was totally destroyed in a hurricane which occurred in 1867.' (Moore).

The Water-Cypress (*Taxodium mexicanum*) near Oaxaca in Mexico is another well-known instance of old trees. Humboldt calculated 4,000 years.

A Yew (*Taxus baccata*) in Braburn (Kent) which is 60 feet in circumference is estimated at 2,880 years. In 1660 already it had a circumference of 56 feet. For this tree we have also a fairly accurate calculation, viz., 3,000 years. A tree in Foullebec on the Eure in France when measured in 1829 appeared to be 1,100 or 1,200 years old. The Yew trees of Fountain Abbey are considered to be 1,250 years old.

Humboldt refers to an oak in the Department de la Charente Inférieure, measuring nearly 90 ft. in circumference near the base. Near Breslau, an oak was blown down by a storm in July 1857, which measured 66 feet in circumference at the base. Their age has been estimated at from 1,000 to as many as 2,000 years. The famous Oak of Mambre, Abram's Oak, was figured by Hooker in the transactions of the Linnean Society. It belongs to the species *Quercus pseudococcifera* Desf. and is popularly supposed to indicate the spot where grew the oak under which the patriarch pitched his tent.

Longevity is a characteristic of all species of oak, but the British oak (*Quercus robur*) is celebrated above all others for the great age to which it attains. In many districts of England, there exist huge living remains of giant oaks, whose age cannot be calculated with accuracy. But on comparison with younger trees authentically known to be 300 or 400 years old, they may be reckoned to have stood for more than 1,000 years.

Many of these ancient trees are historical landmarks, being associated with the events and the names of persons of the remote past. Some of these associations may appear legendary when applied to such as the 'King Oak', in Windsor Forest, which is said to have afforded shelter to William the Conqueror. But it is quite probable that the tree may have been of considerable age at the time of the Conquest. The trunk of this oak measured, 3 feet from the ground, 26 feet in circumference in 1864. If we consider that the 'Cowthorpe Oak' in the village of that name, 6 miles south-east of Knaresborough, had a circumference of 48 ft. at 3 feet above the ground, it is not improbable to assume that the 'Cowthorpe Oak' may be twice the age of the 'King Oak'.

Perhaps the most famous of European trees is the Linden or Lime of Neustadt in Suabia which already in 1226 was mentioned by the chronicler as 'the great tree in the Heerstrasse.' This would give the tree an age of more than 700 years and as it was an old tree when alluded to in the records, we are quite safe in estimating its age as at least 1,000 years.

Another Lime 86 feet in circumference had 815 annual rings.

According to Gregor in Morton's Cyclopaedia the oldest Chestnut tree in England is supposed to be that of Tortworth, the seat of Earl Ducie, in Gloucestershire. It was remarkable for its size in the reign of King Stephen (1135) and was called 'the great Chestnut of Tortworth.' From this we may reasonably conclude that it existed before the Conquest. In 1788 it bore fruit abundantly. In 1820 it measured 52 ft. in circumference 5 ft. from the ground.

But this is a small tree compared with the huge chestnut tree of Mount Etna which measured 204 feet in circumference.

The ancient Cypress tree of Soma in Lombardy is said to have been full grown in the time of Julius Caesar.

In the Berlin Museum there is the stem of a Sequoia (mammoth tree) with a diameter of 15½ feet and 1360 annual rings. As stems of the same tree have been found with a diameter of 54 feet, it can be estimated what their age must be. There can be no doubt that many trees living at the present day must date back far beyond historical times.

The fig tree (*Ficus carica*) reaches quite a considerable age. We know that such trees were reintroduced into England by Cardinal Pole, either when he returned from Rome in 1525 or after his second residence abroad in 1548. The trees were planted in the garden of the Archiepiscopal Palace at Lambeth and have existed for more than 350 years. Another tree was brought from Aleppo to England by Pocock and planted in the garden of one of the Colleges at Oxford in 1648. It was injured by fire in 1809, when the trunk decayed and was removed, but fresh shoots sprang up, some of which were 21 feet high in 1819.

A Plane tree (*Platanus orientalis*) in the meadow of Bujukdere, on the banks of the Bosphorus, is 141 feet in circumference at the base and extends its branches 45 feet from the trunk. It is believed to be more than 2,000 years old.

On Mount Olivet near Jerusalem Olive trees can be seen which are considered to be the same which existed at the commencement of the Christian era.

A Rose tree at the dome of Hildesheim in Germany is said to be over 850 years old.

The Baobab (*Adansonia digitata*) or Monkey-bread tree, also called Ethiopian Sour Gourd, is a native of many parts of Africa. It has been called 'the tree of a thousand years.' Humboldt speaks of it as 'the oldest organic monument of our planet.' Adanson, whose name the genus bears, travelled in Senegal in 1794, where he met this tree. His calculation shows that one of them, measuring 30 feet in diameter, must be 5,130 years old. He saw two other trees from 56 feet in diameter. On their bark were cut to a considerable depth a number of European names. One of these was

dated in the 14th, the other in the 15th century. In 1555 the same trees were seen by Thevet, another French traveller. Livingstone says of the tree: 'I would back a true Mowana (local name of the Baobab in the neighbourhood of Lake Ngami) against a dozen floods, provided you do not boil it in salt water; but I cannot believe that any of those now alive had a chance of being subjected to the experiment of even the Noachian deluge.'

Rashid-ud-Din, who wrote in 1310, mentions a tree at the confluence of the Jumna and the Ganges, which was still in existence 50 years ago enclosed by part of the fortifications.

The sacred Bo tree (*Ficus religiosa*) of Anuradhapura, in Ceylon is said to have been planted by Mehinda 307 years B.C. Another account says that it was planted in the 18th year of the reign of King Deveniplatissa, or 288 B.C. This royal convert to Buddhism, having succeeded in obtaining a branch of the fig-tree under which the Buddha had been wont to sit in meditation, planted it at Anuradhapura, and it is now the venerable tree which we see still flourishing after more than twenty centuries.

E. B.

XLVIII.—A REQUEST FOR MATERIAL OF TRAPA (WATER CHESTNUT)

Prof. Dr. Hugo Glück of Heidelberg the well-known specialist in aquatic plants, is at present engaged in the study of the genus *Trapa*. He assumes that there are 4 species in India: *T. bispinosa, T. incisa, T. bicornis,* and *T. natans,* wild or under cultivation. He is anxious to have *Trapa* material from various parts of India, named or unnamed. Specimens of leaf and fruit are essential. Bazaar-specimens of the fruit, too will be welcome, provided the place of origin can be ascertained.

He also wishes to learn whether there is a *Trapa* with a fruit like this (nat. size) and whether Indian botanical literature has mentioned it anywhere. It is said to come from N. India.

I should be obliged if my colleagues could send specimens directly to me or to the following address:

Prof. Dr. H. Glück,
Heidelberg (Germany)
University,

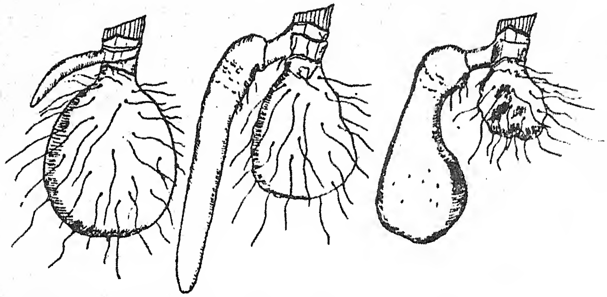
PANCHGANI,
viâ POONA,
March 24, 1930.

E. BLATTER.

XLIX.—NOTES ON *TACCA PINNATIFIDA*, FORST.

(With one text-figure)

This plant appears soon after the break of the rains (June). The inflorescence appears a little in advance of the leaf or leaves (sometimes two appear, though only one is the general rule). It is purely a plant of shady places, usually under trees or among other vegetation. Never out in the open. Such spots as are shaded from the morning and noonday sun are their usual habitat, therefore to the western side of trees,



DEVELOPMENT OF THE NEW CORM IN *T. pinnatifida*
1. June—July. 2. July—August. 3. August—September.

The outside of the corm is light brown, while the inside is white. New corms are formed in the axil of an old leaf, and at first present the form of a thick root. Gradually the new root-like corm becomes thicker and thicker, finally developing into the usual shape of the corm. Unlike the Aroids the new corms grow downwards from the neck of the old corm, while in the Aroids the corms are formed one above the other or to one of the sides. The old corms shrivel up and die. The new corms are fully formed by the end of September. When the corm is taken up and put into a tin of water with the leaf broken off, it develops three to four root-like corms instead of the usual one.

The leaves as stated above are produced a little after the flowers. If the leaf is broken off the plant can be induced to put forth a new one in the same season, here again unlike some of the Aroids, such as *Amorphophallus* and *Sauromatum*. By the end of September or a little later, depending on the rains, the leaves become yellow and collapse. The bract and some of the filiform bracteoles persist to the end. Both the petiole and the peduncle are strongly longitudinally striate in life and purplish.

The fruit begin to develop by the end of June or early July, and are fully matured by the end of September. As soon as the rains give over the whole plant collapses. The fruits are very strongly ribbed.

On the eastern side of the Island of Salsette this plant is fairly common, particularly at Bhandup, where it is plentiful under mango trees, on the way to the Vihar Lake. On the western side of the Island it is not at all common, but is occasionally to be met with. It is particularly a plant of the low-lying country very seldom ascending the hills to any great height.

So far I have not come across this plant within the Island of Bombay.

CHARLES McCANN,
Assistant Curator.

BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY,
October 1, 1929.

L.—A TERRESTRIAL ORCHID FOUND EPIPHYTIC

The members of the genus *Cheirostylis* have always been considered to be terrestrial. The species *C. flabellata,* Wight which up to now had been observed in the Southern Maratha country and N. Kanara, was found in November 1929 by Mr. T. R. Bell at Ambole, 2,000 feet altitude. But instead of growing on the ground it was found on the top sides of the moss-covered stems and branches of *Acacia concinna,* DC., a climber of great size. There was no vestige of earth, and all the specimens were growing in dense shade in 'kumari' lands, in intricate creeper-infested jungle.

So far this species has always been seen as a terrestrial herb and it is interesting to know that it can be epiphytic. It is, of course, quite a possible phenomenon for a species to be both terrestrial and epiphytic, which is known of several species of Orchids.

PANCHGANI, E. BLATTER.
January 19, 1930.

LI.—COLLECTING OF LIVERWORTS AT MAYMYO

Maymyo lies on the Shan plateau, in the latitude of 22° 1′ N. and longitude 96° 28′ E., at the height of 3,508 feet above sea-level. The rainfall is confined chiefly to the months of May to October.

The Algal flora has been investigated by Dr. Ghose (1927), Handa (1928 and Pal 1920). Nothing is known about the Liverwort flora of the place nor of any other part of the province. The writer, with a view to handle the *Hepatic* flora of Burma began his collections at Maymyo and obtained material in October 1928, which proved to be interesting.

The object of this article is to give a preliminary idea regarding the general character of the flora: a detailed account will be published later on.

The collections were mostly limited to *Marchantiales*, this being the group in which the writer was mostly interested. The foliose species were common. The work was started from the Botanical Garden, which lies but a few miles from the railway station. It has many interesting sites and a small lake with many artificial waterfalls which add to its charm and afford good collecting places. Two species of *Marchantia* L. were found. *M. polymorpha* L. was very common in large extended deep green patches on the bank of the lake while here and there were present patches of *M. palmata* Nees. The mouths of waterfalls were crowded with large lobed *Dumortiera hirsuta* Reinw. Bl. et Nees. The plants were more common on the shaded falls.

In the lake near the bank was present yellow flowered *Utricularia* L. and mixed with it were growing species of *Zannchellia* Mich. ex. L., *Potamogeton* (Tourn.) L. and other water plants. On decaying branches were seen green jelly like masses of *Chaetophora elegans* Roth. Upon the path and ground were growing several species of *Riccia* L. the most prominent being *Riccia himalayensis* St. (Ms. *Plagiochasma articulatum* Kashyap) was the chief liverwort

on the exposed stones and mixed with it were found a number of mosses, the most conspicuous being *Bryum coronatum* L. A few specimen of *Targionia hypophylla* L. were also collected.

The Golf course was the next place of collecting. It was not so rich as the first but had some of the interesting forms. *Riccia cruciata* Kashyap and *Fimbriaria angusta* St. were very common thallose forms.

Besides minor collections, the notable and the last was that of Laughing Waters. The path leading from the main road enters into a fairly thick forest under the trees of which were growing a number of mosses, the most common being *Funaria hygrometrica* (L) Sibth. *Fissiden crenutalifolius* Dixon Sp. Nov., *Brachymenium acuminatum* Harv. forma, *Splachnobryum indicum* Hampe & C. M., while the bases were covered with large capsuled moss *Pogonatum neesii* (C.M.) Mitt. Four species of *Anthroceros* L. were collected but these have not been identified so far. Here and there specimen of *Notothylas* Shull were not uncommon. *Cyathodium cavernarum* Kurz. was collected from the bank of the stream.

Some tree trunks were green with vegetation. The major population was composed of Lichens, Mosses and epiphytic Ferns. The most striking moss was *Octoblepharum albidum* (L.) Hedw. with the whitish leaves from which it obtains its name. *Jungermanniales* and Orchids were not rare among the epiphytic growth on the trunks. Under the trees delicate *Hymenophyllum* L. and *Adiantum* L. were not difficult to find. Adder's tongue Fern (*Ophioglossum vulgatum* L.) was not scarce. A waterfall near the Laughing Water was covered with *Dumortiera hirsuta* Reinw. Bl. et Nees. and on the banks were growing *Cyathodium Kashyapii* Khanna, *Marchantia palmata* Nees *Targionia hypophylla* L. and *Fimbriaria* Nees. The *Fimbriaria* Nees material was too young to identify. The same plants were collected from Laughing Waters.

On the whole Maymyo appears to be rich in *Bryophytic* and *Pteridophytic* flora.

In the end the writer has much pleasure in expressing his indebtedness to the Research Fund of the University of Rangoon for a grant which covered the travelling expenses. My thanks are also due to Mr. Dixon for identifying the mosses.

UNIVERSITY OF RANGOON. L. P. KHANNA.

LII. A LIST OF MOSSES FROM DARJEELING DISTRICT

The following species of Mosses were collected by me in the Darjeeling district in May 1929. All were gathered at an elevation of from 6000–8200 ft. For the identification of the species I am indebted to Mr. H. N. Dixon. I also wish to thank the Rev. Fr. E. Blatter without whose encouragement this collection could not have been made.

Acanthocladium penicillatum (Mitt.) Broth.—Tiger Hill, on bark. Alt. about 8200′. 4–V–29. (No. 83).

Brachymenium nepalense Hook.—Tiger Hill, on bark. Alt. about 8200′. 4–V–29; (Nos. 5, 19, 65, 69, 73).

Bryum sp.—(No. 7.)

Campylopus sp.—Darjeeling, on soil. Alt. 6–7000′. 29–V–29. (No. 9.)

Catharinea pallida Ren. & Card.—Birch Hill forest, on moist gneiss rock. Alt. about 7000′. 17–V–29. (No. 1.)

Chionostomum rostratum (Griff.) C.M.—Darjeeling, Lloyd Bot. Garden, on *Berberis Wallichiana* DC. Alt. 6–7000′. 24–V–29. (No. 13.)

Ditrichum tortipes (Mitt.) Par.—Darjeeling, on soil. Alt. 6–7000′. 29–V–29. (No. 63.)

Entodon sp.—(No. 8.)

Funaria hygrometrica (L.)—Tiger Hill, on old mortar of a chimney. Alt. 8200′. 10–V–29. (No. 15.)

Hyophila streptocalypta Dix. *sp nov.* (probably).—(No. 6.)

Levierella fabroniacea C.M.—Darjeeling, on bark. Alt. 6–7000′. 29–V–29. (No. 4.)

Lyellia crispa R. Br.—Darjeeling, on soil. Alt. 6–7000′. 18–V–29. (No. 14.)

Oreoweisia laxifolia (Hook.) Par.—Jalapahar, on decomposing gneiss rock. Alt. about 7000′. 20–V–29. (No. 3.)

Papillaria semitorta (C.M.) Jaeg.—Senchal, on soil. Alt. 8000′ 4–V–29. (No. 2 bis.)

Philonotis longicollis (Hampe) Mitt.—Birch Hill, on moist gneiss rock. Alt. 7000′. 17–V–29. (No. 21, 16.)

Pogonatum aloides (Hedw.) P. Beauv. (probably). (No. 78.)

Pogonatum leucopogon. Ren. & Card.—Senchal, on decomposing gneiss rock. Alt. 8000′. 10–V–29. (No. 62.)

Pogonatum microstomum (R. Br.) Brid.—Senchal, on decomposing gneiss rock. Alt. 8000′. 21–V–29. (No. 10); Jalapahar, on gneiss rock. Alt. about 7000′. 20–V–29. (No. 18.)

Pogonatum Neesii (C. M.) Mitt. (probably).—Senchal, on soil derived from gneiss rock. Alt. 8000′. 4–V–29. (No. 20.)

Pogonatum sp.—(No. 71.)

Pohlia elongata Hedw.—Senchal, on soil. Alt. 8000′. 3–V–29. (No. 17.)

Ptychomitrium indicum (Willd.)—(No. 75.) Apparently a very rare plant.

Rhynchostegiella scabriseta (Schwaegr.) Broth.—Darjeeling, on trees. Alt. 6–7000′. 18–V–29. (No. 11.)

Symblepharis Reinwardtii (Doz. & Molk.) Mitt. f. breviseta.—Tiger Hill, on bark. Alt. about 8200′. (Nos. 7, 87, 101.)

Syrrhopodon Gardneri (Hook.) Schwaegr.—Birch Hill forest, on bark of a conifer. Alt. 7000′. 18–V–29. (No. 22.)

Trachypodopsis crispatula (Hook.) Fleisch.—Senchal, on soil. Alt. 8000′. 4–V–29. (No. 2.)

J. FERNANDEZ.

THE ANNUAL REPORT OF THE COMMITTEE OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING DECEMBER 31, 1929

At the Annual Meeting held on March 26, 1929, the following officers for the year were elected :—

President.—H. E. The Right Hon'ble Major-General Sir Frederick Sykes, P.C., G.C.I.E., G.B.E., K.C.B., C.M G., Governor of Bombay.

Vice Presidents.—H. H. The Maharao of Cutch, G.C.S.I., G C.I.E.; Rev. E. Blatter, S.J., Ph.D., F.L.S. ; and the Hon'ble Sir Ernest Hotson, K.C.S.I., O B.E., I.C.S.

Executive Committee, Bombay.—Mr. R. D. Bell, C.I.E., I.C.S. ; Mr. H. A. W. Brent, Rev. Father J. F. Caius, S.J.; Mr. Alwyn Ezra, F.R.G.S., F.Z.S. ; Prof. V. N. Hate, M.A.; Lt.-Col. F. P. Mackie, I.M.S. ; Mr. J. G. Ridland ; Major S. S. Sokhey, I.M.S. ; Mr. P. M. D. Sanderson, F Z S. ; Mr. A. Todd ; Mr. J. B. Greaves (*Honorary Treasurer*) ; Sir Reginald Spence, Kt., F.Z.S (*Honorary Secretary*).

Advisory Committee, Mofussil.—Mr. T. Bainbridge Fletcher, F.E.S. (Pusa); Mr. T. R. Bell, C.I.E., I.F.S. (Retd.) (Karwar) ; Brigadier W. H. Evans, C.I.E., R. E. (Quetta) ; Lt.-Col. F. C. Fraser, I.M.S. ; Dr. F. H. Gravely, D.Sc. (Madras) ; Mr. C. M. Inglis, M.B.O.U., F.Z.S. (Darjeeling) ; Lt.-Col. R. B. Seymour Sewell, I.M.S. (Calcutta) ; Lt.-Col. C. H. Stockley, O.B.E., D.S.O., M.C. (Fort Sandeman)

During part of the year Mr. J. B. Greaves was on leave in England and Mr. A. Forrington acted as Honorary Treasurer in his absence and at the meeting held on March 17, 1930, at which H. E. The Right Hon'ble Sir Frederick Sykes, P.C., G C.I.E., G.B.E., K C.B., C.M.G., was in the Chair, presented the following report on the Society's finances.

Revenue Account.—Dealing first of all with the Revenue Account—

The figures on the expense side remain very similar to those which appeared last year.

On the receipt side : Life Membership Fees this year are Rs. 1,750 as against Rs. 2,450 in 1928.

Entrance Fees are Rs. 1,814 this year as against Rs. 1,644-8-0 in 1928.

Subscriptions amount to Rs. 28,751-12-8 this year, and last year the total was Rs. 28,556-1-9.

The Taxidermy Department has shown a small profit to the Society of Rs. 192-14-9, which is approximately three times the figures shown as a profit last year.

The total loss on Revenue Account is Rs. 2,995-14-7, but it should be pointed out that during 1929 we have paid for two issues of the Journal which had been left unpaid for from 1928, also more money is now being spent on the Journal, it being the intention of the Committee to make it more attractive and thus increase membership.

Publication Account.—This account shows only a profit of Rs. 115 this year as against Rs. 3,(53 in 1928, but we have in 1929 paid the authors their half share of the profits of their publications for 1927 and 1928.

Balance Sheet.—Dealing now with the Balance Sheet :—The Balance Sheet discloses a satisfactory position.

Assets—The Assets side is self-explanatory with the possible exception of the heading 'GAME BOOKS'. Last year we created a reserve equal to the total value of the Game Books in stock. A number of the Game Books have been sold, and in consequence there is a balance of Rs. 1,917 to be transferred back to the Surplus Assets Account.

Liabilities.—Life Membership fees remain at the same figure, those paid in during the year having been appropriated for General Revenue purposes as it is considered the figure of Rs. 42,600 represents an ample reserve against Life Membership fees.

Under our articles all that is necessary to be done is to maintain Government

Paper investments up to the total value of Life Membership fees. Our investments in Government Paper total Rs. 72,830 as against Rs. 42,600 received from present Life Members.

Donations for Specific Objects Unexpended.—The Society is holding this money as a Trustee.

Surplus Assets.—To last year's balance have to be *added* the profit on publications and receipts from Game Book Sales, and we have to *deduct* a sum of Rs. 3,440 being depreciation on our securities. In no case have any securities been written up and the depreciation is merely a routine one to bring our 3½ per cent securities down to market value on December 31, 1929, the actual value of our securities being considerably above the figure shown.

We also have to deduct the loss shown on the Revenue Account.

The nett difference therefore in the Society's position between last year and this year is a loss of Rs. 4,303-7-5, which appears to be almost entirely due to the necessary heavy depreciation this year on our 3½ per cent Government Securities.

Membership.—During the year, 90 new members have joined the Society, 2 rejoined, and 125 resigned. New members enrolled in 1929 shew an increase of 7 over new members enrolled in 1928, but the Committee regret to report that the resignations in 1929 are 125 as against 103 last year. The total membership on December 31, 1929 was 1,359 including 193 Life Members.

HONORARY SECRETARY'S REPORT

At the same meeting the Honorary Secretary reported as follows:—

The Honorary Treasurer has dealt fully with the financial side—it only remains for the Honorary Secretary to say that he trusts the large number of resignations does but reflect the keenness of his office in getting into touch with members who have left India but who otherwise might have remained 'paper' members and that he wishes members were as keen as his office staff in obtaining new members. No member should ever resign unless and until he has secured a new member to take his place.

The Society's Journal.—The 33rd volume of the Journal was completed during the year. The scientific contributions include:—Mr. Pocock's paper on 'Tigers' in which the author summarizes the characters of the tigers of different countries and indicates the defects in the existing knowledge of these animals. Mrs. Lindsay's paper on Indian Shrews is a comparative study of the species occurring in the Indian Empire. An attempt is made to systematize the group by a careful study of old authorities and literature on the subject along with an examination of the splendid series of specimens collected by the Society's Mammal Survey of India. A new species of Flying Squirrel from Nepal is described by the same author. Mr. T. B. Fry, late I.F.S., who has continued the work of his brother-in-law, the late Mr. Charles Wroughton, I.F.S., with whom he worked also at the British Museum, has contributed a report on the collection of Mammals made for the Mammal Survey by Mr. J. M. D. Mackenzie of Toungoo, Burma. Papers on Birds include:—Mr. P. F. Wickam's 'Birds of the Upper Burma Hills' dealing with the species observed by him in the Chin, Kachin and Shan Hills; Mr. N. F. Betts, 'The Birds of Coorg'; and Major C. H. Williams and Mr. C. E. Williams' 'Notes on the Birds Breeding round Quetta.' Lt.-Col. F. C. Fraser continues his serial on Indian Dragonflies. Other papers on Insects include: The description of a New Species of *Gynaikothrips* from Bangalore by Dudley Moulton; A Note on Indian Lepidoptera by Dr. T. V. Ramakrishna Aiyar; The Life History and Notes on a Caterpillar Pest of Chrysanthemums by M. C. Cherian, B.A., B.Sc.; A Note on the Butterflies and Hawk-Moths of Kathiawar by Lt.-Col. A. H. Mosse, I.A. An account of the Oyster Industry in the Islands of Bombay and Salsette with recommendations for its improvement was written by Mr. H. S. Rai, M.Sc. Father Blatter's Revision of the Flora of the Bombay Presidency has now reached its 10th part. Other papers by the same author were: A Description of a New Species of Balanophora from Mahableshwar, The Mosses of the Bombay Presidency, the High Wavy Mountain and Mt. Abu, and the Flowering of Bamboos (part i). A paper on the Mosses of Waziristan was written by Mr. H. N. Dixon, M.A.

The Editors have continued their efforts to make the Journal appeal to those who are fond of nature but who are not of those who make a scientific study

of it. For the need of these we commenced last year in the Journal a series of articles on Beautiful Indian Trees by Father Blatter and Mr. W. S. Millard. The articles are illustrated in colour and the series will, we believe, meet a long-felt want. Mr. Stuart Baker continues his articles on the Indian Waders, whilst Mrs. Robinson makes it easy by coloured illustrations and descriptive prose to learn something about the Flowerless Plants of India. Mr. Whistler is now doing for Indian Birds what Brigadier Evans did some time ago for Indian Butterflies. In his Study of Indian Birds he provides a 'Layman's Guide' to this interesting subject. A well-illustrated Journal is very popular and should be a means of increasing revenue, but we cannot afford the high cost of publication of so profuse a number of plates unless the Journals bring in a big increase in membership.

Publications.—During the year under review the Committee authorized the publication of the following :—

Game Birds of India.—By Stuart Baker, vol. iii, dealing with the Pheasants. This will be published in the course of the present year. The volume will contain 12 coloured and 5 black and white plates and will be obtainable at special rates by members of the Society.

Coloured Charts of Indian Birds.—A series of charts illustrating in colour no less than 200 species of Indian birds. These charts are published mainly for the use of children in schools but the publication will enable the Society to issue in 1931 a popular book on Indian birds with coloured illustrations of 200 species at a price which would not otherwise enable the book to be really popular. It will be issued on the lines of the Geographical Society of America's 'Book of Birds'.

Identification of Indian Butterflies.—By Brigadier W. H. Evans, C.I.E., R.E. The first edition having been sold out and there being a good demand for a second it is hoped to issue this in 1931.

Poisonous Snakes of India.—By Col. F. Wall, C.M.G. A fourth edition was published in 1929 and only a few copies now remain.

Expeditions and Explorations.—One of the most important of the Society's activities during the year has been the Mammal and Bird Survey of the Eastern Ghats, which has been rendered possible through the generosity of Mr. A. S. Vernay who contributed Rs. 14,000 towards the expenses. Very little is known about the Natural History of this extensive area.

During the Mammal Survey the Society intended to send a collector through the Eastern Ghats but the outbreak of war and other difficulties connected with transport and the unhealthy state of the area prevented our doing so. A survey of Mammals in the area is particularly important as it will add greater completeness to what has already been done during the Mammal Survey and help to link up with the material and data obtained from the neighbouring provinces.

A few sporadic notes on the birds of the Eastern Ghats have appeared in scientific publications but so far no systematic attempt has been made to study the Bird Life of the area.

At the present time, when geographical variation has become an important factor in the study of Indian Ornithology, the absence of adequate material from this extensive area leaves a considerable blank in our knowledge of the Bird Life of the country.

The areas covered by the Survey are the eastern coastal districts of the Madras Presidency and southern districts adjoining the Eastern Ghats commencing with the Ganjam District in the north and ending with the Cuddapah and Trichinopoly Districts in the south.

We have to express our cordial thanks for the co-operation of the Madras Government in extending all necessary facilities to our Collectors. Work was started in the Salem District in May 1929. During the period under review our Collectors have worked in the Trichinopoly, Cuddapah, Salem, Kurnool and Godavari Districts. About 2,000 species of Birds have been collected, and a slightly smaller number of Mammals. Unfortunately during the year the Mammal Collector had to be withdrawn owing to illness but arrangements are being made to replace him. The bird collections are being worked out by Messrs. Kinnear and Whistler at the British Museum, and the Mammals by Messrs. Hinton and Pocock. Reports on the work so far accomplished will shortly be published.

Survey of Birds of Prome.—Owing to the generosity of Mr. J. K. Stanford,

I.C.S., Deputy Commissioner, Prome, the Society was enabled to send a Collector to work under him, Mr. Stanford bearing all the expenses. By this means a large collection of birds was made. The collection is being worked out by Dr. Ticehurst at Tring. Very little material representative of the birds from the Province of Arakan is to be found in Museum collections either in India or England and Mr. Stanford's collections form a valuable nucleus and provide interesting data for the study of Burmese Ornithology. The thanks of the Society are due to Mr. Stanford.

Survey of the Mammals of Toungoo District, Burma.—Mr. J. M. D. Mackenzie has continued actively to interest himself in the Mammal Survey and has made very valuable collections of Mammals in the Toungoo District, Burma. Reports on his collections were published in the Journal during the course of the year.

Wherever possible the Society is always willing to loan the services of collectors to gentlemen who are willing to look after them. Members residing in the more inaccessible parts of India and Burma have the opportunity of doing very helpful work by this means. The work of Mr. Stanford and Mr. J. M. D. Mackenzie in Burma are instances of what may be achieved.

Bird Migration in India.—A scheme for ringing birds with a view to study the problems of Bird Migration in the country was started in 1928. About 5 000 rings were issued in 1928 and a corresponding number have been sent out during 1929. So far 22 recoveries of ringed birds have been reported and the records are being published in the Journal of the Society.

Toxicity of the Venoms of Indian Scorpions.—An investigation into the toxicity of the venoms of Indian Scorpions was announced in last year's report. During the present year great progress was made with the collection of scorpions from various parts of India. The thanks of the Society are due to the Medical Departments of various Provincial Governments who have co-operated in the scheme. A preliminary note on the work carried out and the amount of venom collected was published in the Journal.

Salt Licks.—With the co-operation of the Forest Departments in India and Burma a large number of samples of Salt Licks were collected and despatched to the Society. In addition, samples of ordinary earth and earth used for human consumption were obtained. The material is being analysed by the Rev. Father Caius and Mr. K. H. Bharucha at the Haffkine Institute, and the analysis of earth obtained from Licks is being published in the Society's Journal. Fr. Caius believes that the investigation now being conducted by the Society will be productive of very interesting results and he hopes that it may throw light on the obscure subject of earth eating by human beings. The thanks of the Society are due to all those Forest officials who so kindly helped in the work.

Help Given by the Society.—The Society has been able to assist the following during the past year :—

(1) A large number of Hospitals and Dispensaries and private individuals in India by the identification of poisonous snakes and parasites ;

(2) A local Railway by identifying and recommending measures for the extermination of a ground tick which was causing an outbreak of fever among the station staff ;

(3) The indigenous match industry—by recommending measures for the preservation of timber imported for the manufacture of matches from the attacks of insect pest ;
and in particular by

(4) Recommendation of measures for protection of game in various parts of India.

Game Preservation.—Attention must be drawn to various articles on Game Preservation in India and Ceylon which have appeared in the Journal. The subject is one of growing importance and is attracting attention in all parts of the Empire. The general consensus of opinion in India is that game sanctuaries, if by such are meant areas within which no shooting is to be allowed, are not the remedy. They will be paradises for poachers. What are wanted are Game Preserves in which shooting under regulation is allowed, and the alienation of Forest land, which is the home of interesting species of Forest Game which would be exterminated were the land put under cultivation, should be prohibited. Our present difficulties are mainly due to the increasing number of officials with no interest in sport or natural history,

a universal lowering of efficiency and the facility with which licenses to carry arms are obtained.

The Prince of Wales' Museum.—A great deal of the Society's work now centres in the Natural History Section of the Prince of Wales Museum. The magnificent architectural building, which is a memorial of Mr. Whittet's genius, was not designed for the purpose of a modern natural history museum nor was it ever intended to house in the existing building a Natural History Museum. That Museum was to have been accommodated in a wing and the Museum Trustees have decided that the wing must now be built. There is not sufficient space for the requirements of the Arts, Archaeological and Natural History Sections, let alone the Industrial Section which is clamouring for accommodation in the present building, and whilst the Arts and Archaeological Sections can expand in the existing building if the Natural History Section moves out, the Natural History Section cannot if one of these Sections were to go. The present building is from the lighting point of view alone absolutely unsuited for the purposes of a modern natural science Museum.

The Trustees have accepted designs prepared by Messrs. Gregson Batley & King on plans prepared by our Curator, Mr. S. H. Prater based on what he learnt of modern Museum requirements in the United States, England and the Continent of Europe. The estimated cost may be put at Rs. 5½ lakhs and toward this the Trustees have set aside Rs. 2 lakhs and are making an appeal to All India to contribute to the scheme to make the Prince of Wales Museum a worthy memorial of the King Emperor's first visit to India. Members of the Society have already contributed some Rs. 15,000 but we want contributions to the building fund to come from the general public as members of the Society will have to find the monies for the fitting up of the Natural History Museum and the display, according to latest modern methods, of the collections the Society has brought together. This is not a matter in which the citizens of Bombay alone are interested. It is an All-India matter though it is the work of the Society, called from its place of origin the Bombay Natural History Society, which makes such a Museum a practical possibility.

One thing must not be lost sight of. If a Museum stagnates, it dies. The present position in which none of the existing sections can expand spells death to all. Room must be found for life and expansion, and room cannot be found unless public spirited citizens are also found who will provide the necessary money.

Staff.—The Committee take this opportunity of expressing their appreciation of the work done by the Curator, Mr. S. H. Prater, and his Staff, both scientific and clerical.

REGINALD SPENCE,
Honorary Secretary.

March 8, 1930.

PROCEEDINGS

Annual General Meeting

The Annual General Meeting of the Society was held at the Prince of Wales Museum on Monday, March 17, at 5-30 p.m. His Excellency the Governor, President of the Society, was in the Chair.

On arrival His Excellency was received by the Trustees of the Museum and the Executive Committee of the Society.

The business before the meeting was the adoption of the Accounts and the Annual Report for the year ending December 31, 1929.

The Honorary Secretary's and Honorary Treasurer's Reports and the Balance Sheet and Statement of Accounts, copies of which were in the hands of Members were taken as read and duly adopted.

The Honorary Secretary announced the election of 31 new members since the last meeting.

The Report for 1929 printed on the foregoing pages was taken as read and ordered to be published in the Journal.

The office-bearers elected at the Committee Meeting held on February 12, 1929 were re-elected with the following exceptions and additions :—

Executive Committee.—Mr. A. Forrington, appointed Honorary Treasurer in place of Mr. J. B. Greaves who however remains on the Committee.

Advisory Committee.—The following additional members were elected :— Mr. R. C. Morris (Mysore); Major E. G. Phythian Adams, I.A., (Retired) F.Z.S., (Nilgiris); Dr. Baini Prashad, D. Sc. (Calcutta); and Mr. H.C. Smith, I.F.S. (Maymyo).

His Excellency the Governor in replying to the Honorary Secretary's speech which was a summary of his report given on pages 603–606 said :—

GENTLEMEN,

The Annual Report of the Society which is now in our hands forms a record in a few words of a year's work in many fields about which a great deal migt be said. Although Bombay has the honour of giving its name to this Society, the work and the publications for which it is responsible have an important value not only to India as a whole, but to scientists all over the world, and I think we may all feel satisfied that the standard of all this work has been admirably maintained during the year which is reviewed in the Report.

The Mammal Survey which has been made in recent years by this Society has proved to be of a very high scientific value, and we must all be glad that it has been possible to extend it during the year to the Eastern Ghats and thus to fill in the gaps in what has already been done.

The continued excellence of the Society's Journal is a matter on which we may congratulate both ourselves and the editors (Sir Reginald Spence and Messrs. Sanderson and Prater). The object of the Journal in publishing matter which will be of high interest not only to the pure scientist but to everyone who takes an interest in what he sees around him in India, has been successfully maintained. We have all along been familiar with the series of articles by Mr. Stuart Baker on the Game Birds of India, and the study of Indian Birds by Mr. Whistler is now adding to the attractions of the Journal for laymen. The articles by Father Blatter and Mr. Millard on 'Beautiful Indian Trees' have similarly a universal interest, while the Society has done real service to the public in publishing Brig. Evans' book on the Identification of Indian Butterflies, as is shown by the fact that the first edition has so quickly been sold out. We must remember also the valuable contributions which this Society has been fortunate in obtaining from Colonel Wall regarding the snakes in India, and the important series of articles by Major Fraser on Indian Dragonflies. These and many other notes and papers of interest both to the sportsman and to the student should make our Journal a publication which no educated man in this country would willingly be without, and while in itself it provides an attraction for membership, the expense of its production makes it highly necessary that the strength of membership should be well maintained and, if possible, increased.

I am sorry to see that the figures of membership during the last year have not been altogether encouraging, and we must concentrate on the important task of keeping it up to strength if the Society's work is to go on without check. How we can best do so deserves special discussion, but I would suggest that we should make it our business to see that no tourist visits India without having the work of the Society brought to his notice, and that special efforts might be made to obtain the support of the educated classes and landed gentry both in this Presidency and further up-country. It might even prove fruitful to arrange for the distribution of circulars to visitors at this Museum, but at any rate every means of publicity deserves to be explored.

Ths Society is naturally and rightly concerned with the question of Game Preservation in India, which is alluded to in the Report. The term 'Game Preservation' is really to some extent a misnomer, and it may perhaps create the impression that the preservation of fauna is of interest only to the sportsman. One of the first things we have to do is to bring it home to the public generally that what we are talking about is simply the protection of all wild life. It is simply asserting the right to live of the undomesticated animals and plants of the world. In any country public conscience in matters of this kind is difficult to arouse and can only be expected as a late growth and development of civilization. Even in England we know how difficult it is to persuade the public generally to spare the rarer plants which come within their reach. The

difficulty everywhere is that the assertion of such a principle conflicts with the inherited tradition of mankind that whatever is wild is anybody's prey. Generally speaking, the right of the State to control the predatory instinct and to check destructiveness is recognized only in the case of private property. As we know, even in the most civilized countries poaching in private preserves is regarded very often as a more or less venial and respectable offence. Wherever private ownership does not exist there are three things which make it difficult to limit the predatory inclinations of humanity. One is the innate love of hunting, another is the desire for food, and the third is the passion for wearing things obtained from animals, such as, for instance, feathers. The device by which European countries have to some extent counteracted the first of these tendencies, and to some extent the others, is by introducing the two conceptions so deeply ingrained in most of us, which are summarized in the two words 'game' and 'sport'.

In India, however, the problem of preservation is peculiarly difficult. Shooting for sport alone is comparatively easy to control, although even in this field we have recently discovered rather a serious gap in our education which makes it necessary to appeal to all sportsmen in this country to refrain from the most unsportsmanlike practice of shooting game from the motor car. I sincerely hope that this Society will be successful in setting public opinion strongly against this practice. Apart from sport itself, however, we are confronted in this country with the almost insurmountable difficulty of either compelling or persuading the masses to have any regard for the principle of life preservation. The difficulty is accentuated by the fact that in a certain number of places the interests of the cultivator come into conflict with marauding animals. All the world over it is difficult to convince the farmer that one or two annas of crop are not worth more than the life of any wild animal however rare or local, and the difficulty is not made easier by the fact that they see the sportsman hunting the same wild animal for his own pleasure alone. We must, I think, in fairness see the point of view of the cultivator and endeavour to meet it, but by degrees we may perhaps hope to do something to create a public sense in favour of sparing wild life by enlisting the sympathy of the classes who are more easily educated in this respect, particularly the large landowners.

Another thing which I think we should aim at is to teach the children to appreciate the value of wild life. We must in fact undertake propaganda of a suitable kind to convince the public of two very important truths: Firstly, the irreparable loss to science which is involved in the extinction of any species, and secondly, the danger of upsetting the balance of nature. Even children can and should be taught the fact that nature if left to herself is the best regulator of excess, including even pests injurious to mankind. We already have an example in North Gujarat of what custom and popular belief can do even against the interest of the cultivator by preserving pests, such as the monkey, nilgai and peafowl, when they are protected by religious sanction. At any rate I think it is worth consideration that this Society, or any other Society interested in the preservation of natural life, should begin by getting into touch with the educational authorities, and so to some extent insure the future, and in the meanwhile anything which this Society can do to help to form public opinion on this subject—and there are many possible ways of doing so—will at least be tackling one side of the problem.

One very important way of arousing that interest in wild life which is its only true protection lies in establishing Museums such as this. Anyone who happens to have visited this Museum on a Sunday cannot fail to have been struck and indeed surprised by the numbers of the public who flock to it and take a most lively interest in the Natural History exhibits. One will find here on such days perhaps a majority of people in quite humble circumstances, including many women and children, who can only be daily wage-earners on the week day. That it should be the function of this Museum so to open to these people at least a glimpse of the wealth of the natural life in India speaks volumes for the educational worth of this institution and the value of the money spent on it. From the same point of view the proposed wing of this Museum designed to accommodate the Natural History collections is a thing well worth working for, and it must surely command the fullest support of all who value the scientific work of this Society and the education of the people. We must indeed regret that subscriptions for this object have been so slow in coming in, but I am sure this fact will not daunt us in our efforts,

and I hope that persistence in our appeal during the current year will succeed in making the scheme a practical possibility.

In conclusion, I am sure that we are all ready to endorse the appreciation expressed in the Report of the work done by the Curator, Mr. Prater, and we are grateful, as always, to the Honorary Secretary, Sir Reginald Spence, for his continued valuable services to the Society.

The meeting closed with a hearty vote of thanks to His Excellency the President. After the meeting His Excellency was conducted through the galleries of the Section by Mr. S. H. Prater, the Curator.

BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT DECEMBER 31, 1929

LIABILITIES	RS A P	RS A P
Life Membership Fees		42,600 0 0
Donations for show cases, etc., unexpended.	7,649 5 5	
,, Eastern Ghaut Expedition	2,959 8 3	
,, Himalaya Expedition ...	1,295 4 0	
Building Fund	5,000 0 0	16,904 1 8
Printers for Journals	5,103 6 7	
,, Game Books	1,247 15 2	
For Expenses	250 0 0	6,601 5 9
Surplus Assets—		
As per last Balance Sheet	37,243 6 2	
Add : Profit on Publications	115 7 2	
Game Book Sales	1,917 0 0	
	39,275 13 4	
Deduct— (RS A P)		
Investments Depreciation ... 3,650 0 0		
Loss on Revenue Account ... 2,995 14 7	6,645 14 7	32,629 14 9
Total ...		98,735 6 2

ASSETS	RS A P	RS A P
Investments at par or market value whichever is lower.—		
Rs. 28,000 Govt. $3\frac{1}{2}$% Pro. Notes at $67\frac{7}{8}$%	19,005 0 0	
,, 10,000 ,, 4% 1916/17 Loan at $90\frac{1}{2}$%	9,050 0 0	
,, 15,000 ,, 5% 1945/55 ,, at par.	15,000 0 0	
,, 8,000 Bom. Dev. $6\frac{1}{2}$% loan 1935 at par.	8,000 0 0	
,, 14,000 Port Trust 4% Bond at $74\frac{3}{4}$%.	10,465 0 0	
,, 15,000 Imp. ,, 4% ,, at 74%.	11,100 0 0	72,620 0 0
Cash—		
On Fixed Deposit with Banks	12,500 0 0	
With National Bank of India, Ltd., in Current Account	4,160 11 1	
,, ,, ,, London Account.	354 3 7	
On hand	150 0 0	
Loan to Mr. K. B. Sawardekar ...	80 0 0	17,244 14 8
Sundry Debtors	...	841 9 0
Furniture	2,275 0 0	
Addition during year	140 0 0	
	2,415 0 0	
Less Depreciation	250 0 0	2,165 0 0
Publications excluding Journals at cost ...	...	700 0 0
Note.—Any publications which have been on hand over 2 years have been written off.		
Bird Charts	...	5,163 14 6
Game Books at cost	65,520 10 8	
Less realized to date	55,512 8 0	
	10,008 2 8	
Already written off in previous years ...	11,925 2 8	
Transferred to Surplus Assets Account.	1,917 0 0	
Note.—50% of any profits to be paid to Authors. A stock of 17,750 old Journals and the valuable Research Collection and Library of 2,400 volumes have not been taken into account on the asset side of the Balance Sheet.		
Total ...		98,735 6 2

We have prepared the above Balance Sheet from the cash book and informations given to us, and have verified the investments and deposits.

In our opinion such Balance Sheet represents a true and correct view of the state of the Society's affairs according to the best of our information and the explanations given to us.

BOMBAY, *February 28, 1930.*

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants Auditors.

(Sd.) A. FORRINGTON,
Honorary Treasurer.

REVENUE ACCOUNT FOR THE YEAR ENDING DECEMBER 31, 1929

	RS A P	RS A P		RS A P	RS A P
To Salaries, Income Tax and Contribution to General Provident Fund	22,872 3 0		By Life Membership Fees	1,750 0 0	
,, General charges	941 7 3		,, Entrance Fees	1,814 0 0	
,, Rent	2,436 0 0		,, Subscriptions	28,751 12 8	
,, Printing and Stationery...	714 3 0		,, Taxidermy	192 14 9	
,, Postage	1,415 10 6		,, Interest	5,065 6 0	
,, Library	997 8 6		,, Loss	2,995 14 7	40,570 0 0
,, Furniture depreciation	250 0 0				
,, Fire Insurance	100 0 0				
,, Audit Fee	250 0 0				
,, Journals—Less Sales & Advertisements.	10,592 15 9	40,570 0 0			
Total ...	...	40,570 0 0	Total ...	...	40,570 0 0

PUBLICATION ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1929

	RS A P	RS A P		RS A P	RS A P
To Author's Profit on Snake Charts ...	1,293 0 0		By Sales—		
,, ,, ,, ,, Books ...	350 0 0		Snake Charts	194 12 0	
,, Balance	115 7 2	1,758 7 2	Poisonous Snake Books	645 5 4	
			Society's Publications	918 5 10	1,758 7 2
Total ...	...	1,758 7 2	Total ...	...	1,758 7 2

ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1929 OF INCOME AND EXPENDITURE OF DONATIONS

	RS A P	RS A P		RS A P	RS A P
To Expenditure on Show Cases, Fish Modeller, etc.	4,435 3 9		By Unexpended balance as per last Account	8,195 12 2	
,, Expenditure on Eastern Ghaut Expdn....	9,846 15 9		,, Donations for Show Cases, etc. ...	3,888 13 0	
,, ,, ,, Himalaya ,, ...	708 4 0	14,990 7 6	,, ,, Eastern Ghaut Expdn. ...	12,806 8 0	
,, Balance	...	16,904 1 8	,, , Himalaya Expdn. ...	2,003 8 0	
			,, ,, Building Fund	5,000 0 0	31,894 9 2
Total ...	...	31,894 9 2	Total ...	...	31,894 9 2

BOMBAY, *February 28, 1930.*
Examined and found correct.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants, Auditors.

(Sd.) A. FORRINGTON,
Honorary Treasurer.

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Index to Illustrations	
Errata	
Index to Species	To go at the end of two numbers.

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EDITED BY

SIR REGINALD SPENCE, KT., F.Z.S., M.L.C., **& S. H. PRATER,** M.L.C., C.M.Z.S.

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Page 47 line 9 from bottom *for* **atracapilla** *read* **atricapilla.**
,, 47 ,, 6 ,, ,, ,, *atricapilia* read *atricapilla*.
,, 48 ,, 19 *for* **crythaca** *read* **erythaca.**
,, 89 ,, 12 from bottom *for* **umbriana** *read* **umbrina.**
,, 109 ,, 20 for *harringtonii* read *haringtonii*.
,, 109 ,, 21 ,, *strachey* read *stracheyi*.
,, 110 ,, 28 ,, *longicatudatus* read *longicaudatus*.
,, 111 ,, 29 ,, *affins* read *affinis*.
,, 113 ,, 6 from bottom for *Doyobates* read *Dryobates*.
,, 114 ,, 31 for *harringtonii* read *haringtonii*.
,, 121 ,, 7 ,, *rhodochalmys* read *rhodochlamys*.
,, 133 ,, 12 from bottom for *sibrica* read *sibirica*.
,, 153 Legend to Plate for *sorror* read *soror*.
,, 229 line 11 from bottom for *crcca* read *crecca*.
,, 230 ,, 13 ,, top for *Pulamnaeous* read *Palamnaeus*.
,, 246 ,, 18 ,, ,, ,, *Phyllocsopus* read *Phylloscopus*.
,, 348 ,, 16 ,, ,, *for* **Plegades** *read* **Plegadis.**
,, 393 ,, 30 *for* Harrington *read* Harington.
,, 479 ,, 9 for *senagalensis* read *senegalensis*.
,, 481 ,, 12 ,, *mecranesis* read *mecranensis*.
,, 481 ,, 18 ,, *pondocerianus* read *pondicerianus*.
,, 481 ,, 26 ,, *Hemipodus* read *Hemipodius*.
,, 483 ,, 23 ,, *Geochilidon* read *Gelochelidon*.
,, 485 ,, 17 *for* Matthews *read* Mathews.
,, 569 ,, 9 from bottom for *Trichodroma* read *Tichodroma*.
,, 569 ,, 6 ,, ,, ,, *trogolodytes* read *troglodytes*.
,, 570 ,, 27 for *creca* read *crecca*.
,, 571 ,, 20 from bottom for *fulginosa fulginosa* read *fuliginosa fuliginosa*.
,, 571 ,, 2 from bottom for *Acroceptalus* read *Acrocephalus*.
,, 572 ,, 21 for *Inyx* read *Iynx*.
,, 572 ,, 24 for *pudis* read *rudis*.
,, 572 ,, 30 for *Psitacula* read *Psittacula*.
,, 572 ,, 4 from bottom *Cacabis* read *Caccabis*.
,, 573 ,, 15 for *Chelidonias* read *Chlidonias*.
,, 573 ,, 18 for *nyctiorax* read *nycticorax*.

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